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HOUSE OF LORDS

SESSION 1993-94
4th REPORT

SELECT COMMITTEE ON SCIENCE AND TECHNOLOGY

INTERNATIONAL INVESTMENT IN UK SCIENCE

REPORT

Ordered to be printed 31st October 1994

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REFERENCES IN THE TEXT ARE AS FOLLOWS:

(Q) refers to a Question in oral evidence
(p) refers to a page in HL Paper 36-II of this Session

FOURTH REPORT

31 October 1994

By the Select Committee appointed to consider Science and Technology.

ORDERED TO REPORT

INTERNATIONAL INVESTMENT IN UK SCIENCE

CHAPTER 1 INTRODUCTION

> *"Knowledge is international and universal, and research must be global. That is the general atmosphere in which we like to work" (Q346)*

1.1 In 1992-93, international investment in UK science brought in £1.1bn in industrial R&D funded from overseas, plus £135m to the universities in research grants and contracts[1], and at least a further £129m in fees from overseas science and technology research students (postgraduates £59m, undergraduates £70m). This makes these aspects of science and technology invisible exports worth about £1.4 billion a year, and a great British success story. We set out the figures, and the facts behind them, in more detail in Chapter 2 and Appendix 3.

1.2 International investment is vital to the health of UK science. Globally, £1.4 billion is a significant contribution to the £12 billion spent annually on R&D in the UK. Locally, some universities and university departments depend heavily on income from overseas contracts and student fees; and in some fields, UK industrial research is almost wholly dependent on the activities of companies of overseas origin. Besides money, international involvement makes an incalculable intellectual contribution to keeping the UK in the front rank of scientific nations, and gives British scientists a network of contacts around the world.

1.3 International investment in UK science is thought by some to be controversial. There are those who say that, by locating R&D facilities in the UK, making research contracts with British universities, and placing sponsored professors and research students in leading departments, foreign countries and companies are engaging in "overseas exploitation of UK brains". We consider these concerns in Chapter 3, and conclude that, while UK science is entitled to fair prices for research carried out and a fair return on its intellectual property, there is no case for scientific protectionism.

1.4 The UK's capacity to attract international investment in science faces growing competition from other countries. The successors of Newton and Faraday, Fleming and Whittle cannot rest on their laurels; around the world, and particularly in the Far East, many a nation is cultivating its science base, and attracting investments in science which could have come here. But there are also new opportunities: outward investment in R&D from other developed nations is on the increase, and with many centres of international excellence and the added advantage of the English language the United Kingdom should aim to receive a handsome share. The Government rightly pursues a general policy of welcoming international investment in UK science; in Chapter 4 we consider a range of detailed policy areas in which this welcome could be better expressed.

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[1] Source: Universities Statistical Record. Former polytechnics not included. £81m from EU, £54m from overseas industry.

1.5 International investment in UK science is not part of the common currency of science policy discussion. We believe that it should be: it has vital implications for Government, the UK science base, and our academic and industrial partners overseas. We hope that readers of this report in all these areas of interest will find that it opens up a subject which is going to become increasingly important.

INWARD INVESTMENT

1.6 International investment in UK science is, in part, a subset of a much bigger picture of inward investment in the UK economy. Most inward investment is in manufacturing, as companies operating internationally seek to manufacture closer to their markets. During the 1980s, the UK attracted, as a proportion of GDP, the most inward investment of all the G7 countries and by value the second most after the USA; and the UK has attracted more inward investment from the USA and Japan over the last 40 years than any other member of the EU[1]. As this report neared completion, it was announced that the South Korean electronics group Samsung is to invest £600m in new manufacturing plants and training and administration units on Teesside: this will be among the largest single inward investments in the EU this year.

1.7 In the Government's words, "Inward investment indeed contributes to increasing the innovative and technical capacity of UK industry" (response to 1st Report of the House of Commons Science and Technology Committee, September 1994, Cm 2659). Professor Michael Gibbons of the University of Sussex Science Policy Research Unit commented, "Although in the first instance FDI [Foreign Direct Investment, ie inward investment] tends not to be R&D investment, the simple fact of setting up advanced manufacturing plant in the UK brings in its train a demand for R&D and for qualified manpower that is best supplied locally. So, indirectly, FDI does constitute an investment in the science base" (p275).

DEFINITIONS

1.8 "International investment in UK science" includes any deliberate decision to allocate resources for science from overseas to the UK (including resources, notably EU funds, to which the UK has contributed). By "science" we mean scientific research and development in all the natural sciences, including engineering, medicine and agriculture. We use the expression "the science base" to mean the universities and research councils; but we are equally interested in research and development in industry and the private sector. By "investment" we mean any allocation of funds, including capital investment and current spending on salaries and overheads, grants, contracts and fees. By "international" we mean originating overseas, whether from governments, commercial organisations, trusts, foundations or any other source, and whether from other member countries of the EU or any other country.

1.9 There is a list of abbreviations at Appendix 6.

CASE STUDIES

1.10 In Appendix 4 we offer a detailed examination of investment in UK science from Japan. Japan is not the only source of such investment, nor even the biggest (that is the USA). But she is a major scientific partner, and has been the focus of extensive attention in this respect in recent years; and experience of scientific relations with Japan may hold lessons for relationships with other countries in the same region now entering the first division of international science.

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[1] Figures on inward investment abound. Recent analyses may be found in *UK Technological Competitiveness* (Parliamentary Office of Science and Technology, July 1993), *The Import and Export of Jobs* (House of Commons Employment Committee, January 1994, HC 160), *Competitiveness of UK Manufacturing Industry* (House of Commons Trade and Industry Committee, April 1994, HC 41), and the Government's recent White Paper, *Competitiveness: Helping business to win* (Cm 2563, paragraphs 8.37-60).

1.11 In Appendix 5 we offer in similar detail an examination of international investment in UK science in the field of pharmaceuticals. There are other key areas which we could have chosen - notably motor vehicles and electronics. Our choice reflects partly our own expertise, and partly the evidence of our witnesses. On the one hand, pharmaceutical R&D is an area of enormous success for the UK: five of the world's twenty best-selling pharmaceuticals were researched and developed in the UK; almost every major international pharmaceutical company conducts research here; and the UK receives 8% of the industry's global R&D budget though accounting for only 6% of world production and 3% of global consumption. On the other hand, in this sector more than any other, our witnesses suggested that the UK's leading position as a location for international investment in science may be under threat.

COURSE OF THE ENQUIRY

1.12 This report was prepared by Sub-Committee I, whose members are listed in Appendix 1. The Chairman was Lord Walton of Detchant. The Specialist Advisers to the Sub-Committee were Dr Peter Collins, a member of staff of the Royal Society, and Dr Paul Whittingham. Sub-Committee I held 15 meetings; they received evidence from the persons listed in Appendix 2, to all of whom we are grateful. We are also grateful to the staff of the Oxford University Department of Pharmacology, the Yamanouchi Research Institute and Sharp Laboratories of Europe Ltd, who received members of the Sub-Committee who visited Oxford on 9 March; and to the Royal Society of Edinburgh, in whose rooms the Sub-Committee met on 25 May.

CHAPTER 2 INTERNATIONAL INVESTMENT IN UK SCIENCE

References to figures and tables prefixed A are to Appendix 3

UK RESEARCH INCOME FROM OVERSEAS

2.1 Total annual UK intramural R&D spending (GERD - Gross Domestic Expenditure on R&D) has been between £12 and £13 billion, in real terms, since 1986-87. Of the total cash spend of £12,619 million for 1992-93, a significant proportion, £1,374 million (or 10.9% of the total) is funded from overseas sources. See Table A1 and Figure A1.

2.2 By far the largest part of this £1,374m (80% in 1992-93) is received by UK industry. Next comes the UK universities (excluding the former polytechnics, for which figures are not yet available) with 9% in 1992-93. The remainder is received by Research Councils and Government. Overseas R&D income is approximately one quarter defence-related and three quarters civil-related; the defence component of industry funding is showing a significant decline. See Table A2.

2.3 A detailed breakdown of income, by receiving sector, is provided in Table 1, which also shows fee income from overseas for students in science subjects.

Table 1 UK research and student fee income from overseas

Real Terms; £m; 1992-93 values	1990-91	1991-92	1992-93
Research Councils	25*	25	25
Civil Departments	0*	0*	0*
Ministry of Defence	7*	6*	9*
Universities: grants and contracts	110	116	135
Universities: student fees	110	118	129
Industry	1386	1288	1186
TOTAL	**1638**	**1553**	**1484**

*Estimated

PUBLIC SECTOR SCIENCE

2.4 Research grant and contract income for all UK universities and all disciplines, excluding the former polytechnics, has risen sharply from £638.7m in 1988-89 to £1,106m in 1992-93. A growing proportion of this is from overseas sources: £61.4m (9.6% of the total) in 1988-89 to £134.6m (12.2% of the total) in 1992-93.

2.5 Total overseas funding can be split into income from the official organs of the European Union (mainly the EU Framework programme) and income from overseas industry. Divergent trends are seen, with significant real increases in EU source funding accounting for the overall growth. There are also distinct regional trends, with Wales and Northern Ireland significantly increasing their (albeit small) share and with greater dependence on EU funds. By contrast funds from overseas industry have shown a significant decline in recent years and are now smaller than EU funding. See Figures A5 and A6.

2.6 Most universities receive income from overseas but the majority is concentrated in a small number of universities: half the income from overseas industry comes to just eight universities; 14 universities receive half the income from the EU. See Figures A3 and A4, which show that different institutions do better at securing income from different sources, and different institutions do better in different years. In 1992-93, computer sciences, non-medical biological sciences and electrical and electronic engineering attracted the most income from official EU sources whereas medicine, other biological sciences and pharmacology received the most from overseas industry sources: see Figure A7.

2.7 We have not conducted a comprehensive survey of international investment in UK universities, and hence the examples we quote are inevitably selective. However, we have looked behind the statistics shown above in four particular cases. Top of the league for income from overseas industry (see Figure A4) is Oxford University (p10). On average over the last 5 years, overseas sources excluding EU programmes have provided about 14% of Oxford's research grant and contract income, about £8m per year, largely concentrated in the biological-medical field. EU programmes provide a further £2.4m (4%). In addition, in 1993-94 there were 459 postgraduate students in residence from outside the EU (biological sciences 86, mathematics 78, medical sciences 101, physical sciences 194). Oxford regards this a sheer gain (p8) to the University and to the nation. Besides increased opportunities and funds for science and the training of scientists, international investment offers "a much clearer view of the techniques in innovation employed by foreign companies...helping researchers to ensure that their work has real value in an international context".

2.8 Cambridge University also receives considerable benefit from overseas sources, with increasing emphasis on European programmes. Excluding the latter, overseas income averaged 5.3% of all Cambridge research and contract income over the last three years, some £3m in 1992-93, but this belies the extent of involvement with other overseas companies throught their UK subsidiaries. EU programmes in 1992-93 provided a further £3.8m (6%), with much potential for growth. As well as the involvement of overseas investors through formal research contracts, there are significant informal research collaborations and unquantifiable donations in kind. Also in 1992-93, there were 382 overseas PhD students in science subjects in residence from outside the EU, who provided £2.6m in tuition fee income. Many were sponsored by special schemes established by the University, the Cambridge Commonwealth and Overseas Trusts (and, currently under development, a Cambridge European Trust). The University believes that "these international links all serve to enrich the intellectual breadth and vigour of our research activity in general" (unprinted letter).

2.9 The only institution to receive more from the EU than Cambridge University in 1993 was Imperial College (University of London) (p1). On average over the last four years, overseas sources excluding EU programmes have provided about 9% of the College's research grant and contract income, about £4.3m per year; EU programmes have provided as much again. The College expects to maintain this level of foreign funding. Companies whose principal operating base is not in the UK sponsored College posts worth about £300,000 in 1992-93, amounting to 20% of all such sponsorship; and in the same year 509 PhD students from outside the EU (38% of all PhD students) provided £3.8m in fee income. According to the College, this too is sheer gain, rather than substitution for support which could have been found at home. The result is "a more vigorous research programme, in both a scientific and financial sense" - extra money, and a wider range of projects - and "perhaps 10% more trained researchers contributing to advancing the UK science base". This year, the College was one of the winners of the Queen's Award for Export Achievement, in respect of an increase of "gross overseas earnings from services" (ie non-EU student fees, plus research grants and contracts from non-UK sources including EU programmes).

2.10 We have comparable figures for Loughborough University of Technology (p269). Between 1987-88 and 1992-93, overseas research grant and contract income increased by 50% to £2.5m per year (18% of all research grant and contract income). Most of this consisted of EU grants; in 1992-93, other overseas contracts brought in only £195,000. On the other hand, the Water Engineering and Development Centre, which provides consultancy and taught courses for developing countries and is strongly supported by the ODA, the International Labour Organisation and the World Health Organisation, earned just over £1m in 1992-93; and fee income from overseas science students doubled over 1987-93 to £4.4m per year. (Loughborough estimates that at least as much again passes from overseas students directly into the local economy - Q253.)

2.11 Many UK universities have increased their chances of attracting industrial investment by establishing, or making links with, a Science Park. Science Parks began in the 1950s in the USA; the first Science Parks in the UK were set up in 1970 by Trinity College, Cambridge, and in 1971 by Heriot-Watt University in Edinburgh; there are now 30 Science Parks in England, four in Scotland, six in Wales and one in Northern Ireland. No two Science Parks are quite alike; but all are property-based initiatives, associated with a research centre (in all but two cases, a university), designed to encourage knowledge-based businesses and technology transfer. Overall, around £500m has been invested in the Parks themselves, of which 52% has come from the private sector, 30% from central and local government, and 18% from the universities. Over 1,000 companies, mostly small ones, are established on a Science Park, employing in total around 15,000 people; around 7% of these companies are of overseas origin[1]. Members of Sub-Committee I visited Sharp Laboratories of Europe Ltd on the Oxford Science Park in March.

2.12 Total R&D income to the Research Councils from overseas is about £24 million with 37% coming from the European Commission. SERC (now EPSRC, PPARC and part of BBSRC) receives about half of the total. See Table A4.

INDUSTRIAL SCIENCE

2.13 Industry-funded R&D is by far the largest component of UK GERD. Likewise money received by industry comprises the largest proportion of overseas funded R&D. The percentage of industry funds coming from overseas has risen from £727m, 12% of UK Business Enterprise R&D (BERD) in 1981-82, to £1,186m, 15% of BERD in 1992-93.

2.14 The DTI (QQ73-88) analysed for us the different but equally revealing figures for R&D funded by overseas-controlled companies, though not necessarily from overseas funds. In 1992-93 this amounted to £1.8bn, 23% of BERD. Of this £1 billion (55%) was funded by US-controlled companies, £300 million (17%) by Japanese-controlled companies (including ICL), and £500 million (28%) by companies controlled elsewhere. American companies have been investing in British science since the Second World War; European investments have grown steadily over the last 15 years; Japanese investment is a phenomenon of the last five.

2.15 According to the last "benchmark" survey of industrial R&D by the Central Statistical Office, done in 1989, 83% of this expenditure by overseas-controlled companies is concentrated in three sectors: electronics, chemicals/pharmaceuticals and vehicles, in that order. We have had evidence from overseas companies investing in UK science in the first two of these sectors. Our samples are not representative, but give an idea of what lies behind the figures. There are of course other sectors, eg medical equipment, design and production and the energy industry, in which international investment in UK R&D is significant; we have not attempted a comprehensive survey.

Electronics

- IBM (UK) (Q686) spend £145m per year on UK R&D, including their Hursley Park Laboratory in Hampshire with 1,300 staff.
- Northern Telecom's R&D subsidiary BNR has 1,500 staff in the UK, including 840 at the former Standard Telephones and Cables laboratory at Harlow in Essex. Besides intramural R&D, they spend over $1m per year in the UK science base (p168, Q655).
- Olivetti (p181, Q688) have their only corporate research laboratory in Cambridge, with 30 staff and an annual budget of £2.5m. The laboratory has close links with the Cambridge University Computer Laboratory.

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[1] Source: Directory of the UK Science Park Association. See also *An Assessment of Firms Located On and Off Science Parks in the UK* by P Westhead and D J Storey of Warwick Business School, HMSO October 1994, ISBN 0-11-515377-2.

— Philips (p248) have a corporate research laboratory at Redhill in Surrey, with 250 staff of whom 170 are engineers. They also have 100 people doing advanced development at manufacturing sites. Their other corporate laboratories are in the Netherlands, Germany, France and the USA.

— Siemens (p255) have 5,000 R&D staff in the UK, and spent £127m in 1992-93. Most of this is D; they do R in Germany and the USA. Some is linked with manufacturing; but Roke Manor, which originally belonged to Plessey, serves Siemens worldwide.

Chemicals/Pharmaceuticals

— Bayer (p224) have 50 staff in the UK doing preclinical research on respiratory diseases, and 100 doing clinical research in cardiovascular, central nervous system, infectious diseases, diabetes and asthma.

— Ciba-Geigy (p229) have a corporate laboratory in Macclesfield, with 500 research staff and a budget of £30m.

— Eli Lilly (p241) have 300 R&D staff in the UK, mostly at their Research Centre at Windlesham in Surrey. This amounts to 10% of their R&D worldwide; other facilities are in the USA, Germany, Belgium, Spain, Canada and Japan.

— Hoechst (p239) spend most of their R&D budget in Germany. In the UK, they have 200 staff in pharmaceutical/clinical research in joint venture with Roussel Laboratories, 600 researching crop protection in joint venture with Schering Agrochemicals, and 200 in other areas or subsidiaries.

— Merck Sharp & Dohme (p245) has several R&D units in the UK, including the Neuroscience Research Centre in Harlow, with 250 researchers and a budget of £30m. They put £250,000 per year into university collaborations.

— Pfizer (p246) have a Central Research laboratory in Sandwich, Kent, focused on cardiovascular drugs. This is the largest research centre outside the USA of any US pharmaceutical company.

— Rhone-Poulenc Agriculture (p250) have a Research Centre at Ongar in Essex, with 180 staff, specialising in herbicides and environmental impact. RPA have similar Centres in Lyon and the North Carolina Research Triangle Park. Rhone-Poulenc also have pharmaceutical R&D in Dagenham, Essex, and chemical R&D in Avonmouth, Manchester and Leeds; their total UK R&D spend is £40m.

— Roche (p251) have a Research Centre in Welwyn, with 320 staff in non-clinical R&D, 80 in clinical R&D and 180 in "discovery research" in virology/inflammation and autoimmune disease. They have similar centres in Switzerland, the USA and Japan.

In the third key sector, vehicles, Ford's R&D facility at Dagenham is possibly the largest single international investment in UK R&D, and Nissan's R&D groups in Sunderland and at Cranfield constitute the biggest such investment from Japan. (The evidence of Japanese companies is noted separately in Appendix 4.) Following the recent acquisition of Rover Group by BMW, investment by Rover in R&D is expected to grow over the next five years.

WHY DO INTERNATIONAL COMPANIES INVEST IN UK SCIENCE?

2.16 Twenty major international companies investing in UK science in a range of sectors have explained to us why they are here. Generalising from their responses would be foolish: each company's story and situation is unique; we may not have heard the whole story; it may even be that different people within the same company would give different explanations.

2.17 However the following very general picture emerges from what we have been told. Investment in research aimed at developing products for a particular market — "little r and big D" — tends to be colocated with production ("The scale of our UK research operations reflects the scale of our exploration and production activities" — Elf Petroleum, p230), in a location suitable for supplying that market (Nissan's European Technology Centre at Cranfield exists "to get its engineers closer to the individual markets and customers", p246), and one which can provide the skilled staff needed for both production and R&D. According to Andrew Cook of the Manchester Business School R&D Research Unit (p271), this form of investment is increasing as international companies seek to make product development faster and more responsive. The UK can hope to attract such investment from companies supplying the European market, in competition with the other countries of the EU, notably France and Germany. On the other hand, corporate strategic research — "big R and little d" — may be located anywhere in the world. There is a tendency to look first for a location close to corporate headquarters, but, once a company looks beyond its own "backyard", strategic research may be located anywhere. Olivetti is an interesting case (p181): its laboratories in northern Italy and California have been converted from corporate research to development, leaving its only corporate research laboratory in Cambridge.

2.18 In both these contests, the UK starts with one immense natural advantage, cited by Kobe Steel (p240) and Sharp (p253) and technical managers interviewed by researchers from Manchester Business School (p271): the English language, which is the international language of science and widely spoken as a second language.

2.19 The other most widely quoted reason for investing in UK science is its sheer excellence and capacity for innovation:

> "The UK science base has always been seen as strong and a valuable source of creative exploratory science" (Ciba-Geigy, p229)
>
> "[Kobe Steel] located its European research laboratory in the UK because of the high reputation of the UK science base in materials science generally, and composite materials more specifically. There was some debate whether Germany would have been a better choice because of a perception that Germany had a better technological base..." (p240)
>
> "The UK enjoys a high reputation for the standard of basic research and research training in higher education" (Sharp, p253)
>
> "The most attractive feature of UK science which lends itself to collaborative research with a multinational corporation is the strength of the basic, curiosity-oriented research and its associated infrastructure" (Toshiba, p255)

2.20 Japan appears to be a special case: see Appendix 4. Of particular importance to Japanese investors coming to the UK are the warmth of the welcome they receive, at both the official and social levels; personal contacts and relationships built up over time; and the willingness of academic researchers to make relationships with industry.

2.21 Special factors also affect investment decisions in the pharmaceutical sector. The companies we have spoken to cited the excellence of the science base, and the relative generosity of the R&D allowance in the Pharmaceutical Price Regulation Scheme (PPRS); they also cited the excellent NHS infrastructure for clinical trials, the relatively rapid product licensing system, and the impending arrival in London of the European Medicines Evaluation Agency. Some of our witnesses, however, expressed concerns in respect of the science base, the PPRS and the clinical infrastructure: these are set out in Appendix 5. In September, the Secretary of State for Health set up a government-industry team to encourage inward investment in pharmaceuticals: the chairman is Sir Richard Sykes, Chief Executive of Glaxo Holdings plc; the team will visit Japan and the USA in 1995.

2.22 Various other special factors may come into play. David Ball of Northern Telecom (Q668) explained to us how the UK is temporarily the ideal location for R&D in telecommunications, because of the rush of activity and investment following partial deregulation: "Quite simply there is an enormous experiment in telecommunications going on in a particular laboratory which is called the United Kingdom". Location decisions may also be influenced by political considerations, such as "avoidance of trade friction" and "image building" (cited by Sharp, p253; cp Northern Telecom Q668). An R&D facility may be acquired as part of a merger or takeover: eg Hoechst (p239), who acquired Berger Jenson Nicholson in 1968 with 200 R&D staff in the UK, or Northern Telecom, who acquired Standard Telephones and Cables (STC) with its Harlow laboratories in 1991; it may be impossible to say how far the acquisition of the R&D facility influenced the deal.

2.23 We do not attempt to rank these various reasons why an international company may choose to invest in UK science. But we note that, with the important exceptions of language, welcome at the social level, and matters related to the marketing strategy of the individual company, they are all susceptible to influence, for good and ill, by public policy.

OVERSEAS STUDENTS

2.24 In 1991-92, UK further and higher education enrolled 37,100 overseas science students: see Table 2.

Table 2: Overseas full-time science students 1991-92

Postgraduate	14,200
First Degree	18,200
Other Higher Education	3,200
Further Education	1,500
TOTAL	37,100

Source: Education statistics for the UK 1993, Table 24, subject groups 1-7.

2.25 There is a large global market in education and training, in which the United Kingdom science base is a major player: see Tables 3-5.

2.26 Table 3 shows the UK's market share of all overseas students steady at around 6%. Countries increasing their market share are, within Europe, Germany and Belgium, and in the Pacific, Australia and Japan.

2.27 Table 4 shows that the UK is the first choice destination for students travelling from the USA and the Republic of Ireland; second choice after the USA for students from Malaysia, France and Germany; and the preferred European destination for students from Hong Kong, Singapore and Japan, and from France. It also shows that the intake from Malaysia has fully recovered from the slump which followed the imposition of full-cost fees in 1981.

2.28 Table 5 shows that the distribution of countries of origin among postgraduate science students in the UK differs from the distribution for all students. All the top 14 student-sending countries figure among the top 25 postgraduate-scientist-sending countries, but they are joined by others, notably Brazil and Pakistan.

2.29 Our witnesses from the British Council identified some trends (Q317): the number of students coming to the UK from other EU countries has increased substantially since 1979, and now constitutes one third of the total; as regards choice of subject, the proportion of overseas students enrolling for UK science has declined over the last five years (though absolute numbers are rising, by about 4% per annum for postgraduates and 11% per annum for undergraduates - see Tables A14-A16). The Council (p78) is aware of the emerging competition from Australia and Japan: Japan has a national policy, announced in 1983, to increase her overseas student population to 100,000 by the end of the century; Australia is targeting south-east Asia, and now attracts as many students from that region as does the UK, mostly from Hong Kong, Malaysia and Singapore (see Table 3).

Table 3: Foreign students enrolled, all levels and subjects, top 9 host countries

Figures in thousands

	1970	1975	1980	1980 SHARE	1985	1985 SHARE	1990	1990 SHARE
USA	145	179	312	35%	344	36%	408	32%
France	35	94	111	13%	132	14%	136	11%
Germany	28	54	62	7%	79	8%	107	8%
UK	25	49	56	6%	54	6%	80	6%
Former USSR	30	43	63	5%	-	-	67	5%
Canada	22	23	28	3%	29	3%	35	3%
Belgium	9	10	13	1%	25	3%	33*	3%
Australia	8	8	9	1%	16	2%	29	2%
Japan	4	6	7	1%	12	1%	24*	2%
WORLD TOTAL	-	-	880	100	969	100	1262	100

Source: UNESCO statistical yearbook. Foreign means non-permanent resident, not non-national.

SHARE = % of world total. *1989

2.30 Witnesses from Oxford University and Imperial College confirmed that attracting overseas students is "a very competitive business" (QQ56-57). For "the best postgraduates in the world", the choice is "usually between the UK and the United States". The USA has in her favour the higher standard of university equipment; though the Vice-Chancellor of Oxford University tentatively advanced the argument that students from developing countries may be more attracted to departments where conditions and resources resemble more closely those in their home country, to which they expect to return! Imperial College mentioned some elements of their competitive strategy: representation at student recruitment fairs around the world; their inherited network of contacts around the Commonwealth; and direct contact with ministries of education in sending countries.

2.31 Witnesses from Loughborough University and UMIST told us a similar story (QQ295-301). They are in "very direct strong competition" with universities in the USA, Canada, Australia, Japan, France and Germany - and with each other. They have the advantages of the Commonwealth connexion, and the similarity of educational systems which goes with it, and the English language. They can make up for their relative lack of equipment by close relationships with up-to-date industrial laboratories. UMIST's Director of Overseas Students conducts collaborative marketing through the "Northern Consortium" of universities. Loughborough assists companies such as British Aerospace to put education and training packages into bids for overseas contracts as "offsets"; it also uses its network of former students, and contacts with overseas ministries of education.

Table 4: Competition for students from 14 countries sending most to UK

	Students in UK, 1990	Other leading host countries, nearest available year
Malaysia	7661	USA 12645, Australia 7294, Canada 1565
Hong Kong	6687	USA 13191, Canada 6893, Australia 5137
USA	5401	Germany 4207, France 3474, Canada 2972
Germany	4765	USA 7573, France 5674, Switzerland 5515, Austria 4881
Ireland	4680	USA 1251
France	4229	USA 5580, Germany 3871, Switzerland 2836
Greece	4003	Germany 6760, Italy 5172, USA 4489, France 2631
Singapore	2447	USA 4755, Australia 3542, Canada 1216
Spain	1850	USA 4589, France 2957, Germany 2787, Belgium 2023
Cyprus	1804	Turkey 2570, USA 1811
Norway	1720	USA 2412, Germany 943
China	1577	USA 78493, Japan 12609, Germany 5172, Canada 3570, France 2419, Australia 1558
Italy	1447	Belgium 5917, Austria 4381, Germany 3748, Switzerland 3741, USA 2486, France 2434
Japan	1390	USA 40700, China 4340, Germany 1219, France 1085

Source: UNESCO statistical yearbook. All subjects, not just science; all levels, undergraduate and postgraduate. China includes Taiwan.

2.32 Professor Burke of the University of East Anglia agreed (Q352): "We have to meet competition from Australia and the United States. So we have to offer a product that is worth paying for. In general, we have been able to compete".

2.33 Unlike some countries, the UK does not routinely subsidise the teaching of overseas (non-EU) students from the education budget (p188). However, a range of publicly-funded scholarships is available, and overseas postgraduate research students are counted by the HEFCs towards the quality and volume measures for research funding (p212).

UK RESEARCH EXPENDITURE OVERSEAS

2.34 International investment in science is a two-way street; money for science flows out from the UK as well as coming in. It is possible to put figures on some of this, but not on the whole of it: see Table 6.

Table 5: Overseas student enrolments for UK postgraduate science 1992-93: top 25 countries of origin

Greece	1030
China	925
Malaysia	886
Brazil	590
Germany	586
Hong Kong	542
Ireland	489
France	457
Pakistan	455
Taiwan	358
Turkey	341
India	339
Singapore	301
Nigeria	291
Spain	279
USA	234
Canada	177
Italy	172
Kenya	160
Netherlands	157
Japan	154
Belgium	103
Cyprus	93
Norway	63
Israel	48

Source: British Council Education Counselling Service (p77)

Universities

— No figures exist for university funding of R&D abroad. University extra-mural spending on R&D was £90 million in 1992-93. It is assumed on this basis that overseas R&D funding by universities is very small.

Research Councils

— This covers predominantly international subscriptions made via the Research Councils. It has been level in real terms over the last 3 years at around £107 million, spent mostly through the former SERC. See Tables A5 and A6 and Figure A10.

Table 6: UK research expenditure overseas

Real Term: £m: 1992-93 values	1990-91	1991-92	1992-93
Research Councils	112	110	111
Civil Departments	90	94	110
Ministry of Defence	162	175	171
Universities	Small	Small	Small
Students studying abroad	Not Known	Not Known	Not Known
Industry	Not Known	Not Known	Not Known
UK EU Notional Payment	229	197	251
TOTAL	Not Known	Not Known	Not Known

Government Departments

— A growing amount and proportion of civil department extra-mural R&D spending goes overseas: £82 million in 1990-91, £109 million in 1992-93. Ministry of Defence overseas spend has risen from £145 million to £170 million over the same period. Total Government R&D spending abroad has risen from £329 to £391 million over the last 3 years See Tables A7-A9 and Figures A11-A13.

Business Enterprise

— No comprehensive public accounts exist from which to establish the extent of UK business investment in R&D overseas.

NEW POLICY FOCUS FOR THE DTI

2.35 Over the last two years, the DTI has adjusted its inward investment activities to give more attention to investment in R&D (QQ61, 79):

(a) A sub-group of the Overseas Projects Board has been set up to deal exclusively with the education and training sector. The Group is committed to increasing activity in overseas scientific links, paying particular attention to the flow of postgraduate students from overseas, inward investment in research and development, academic collaboration and the use of UK expert consultants. The remit of the Group includes the task of maintaining the UK's share of the overseas student market. The Chairman of the Education and Training Export Group is Lady Perry of Southwark, a member of this Committee.

(b) A new unit was created in July 1993: the International Branch of the Innovation Policy Division (QQ61-4). (In March 1994, the International Branch was transferred to the Management and Technology Services Division.) The Branch is responsible for:

(i) the Overseas Science and Technology Expert Missions (OSTEMS), which support small groups of senior industrialists on short overseas visits to study particular technologies;

(ii) the Overseas Technical Information Service (OTIS), which supplies information gathered by Embassy Science and Technology Sections and British Council Science Officers to government and, on subscription, to the private sector;

(iii) the Engineers to Japan Scheme (see Appendix 4).

(c) The Invest In Britain Bureau (IBB)[1] organised a seminar in Tokyo in September 1993, as part of a visit by the Minister for Science, Mr William Waldegrave, to introduce 295 Japanese businessmen to the UK as a location for R&D.

2.36 These activities make it clear that the DTI is committed to encouraging international investment in UK science. Dr Geoffrey Robinson, speaking as Chief Adviser on Science and Technology to the DTI[2], confirmed this (Q79):

> "The world of research and development is becoming increasingly international. In all honesty, it always has been, but we are recognising that there is really only one research and development ability around the world. If the United Kingdom wants to succeed long term in the future, we have to hold our own as a place in which research and development is done, not just in the science base but in industry as well, and that means being truly global in that mind-set".

2.37 However Dr Robinson acknowledged that an unqualified welcome for international investment in UK science is a contentious policy:

> "There are arguments that flow backwards and forwards about overseas exploitation of United Kingdom brains and so on. The United Kingdom has taken a very positive view that being part of the truly global, multinational economy, we have to accept that on average we are going to benefit from strengthening those international relationships, and so we are proactive".

In Chapter 3, we proceed to test the truth of this assertion.

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[1] The IBB (QQ68-72) exists to promote inward investment in all forms; it works overseas through Embassies, including 33 full-time staff in the USA, Canada, Japan, Germany, Switzerland, Taiwan and Korea, and in the UK through the six English regional development organisations and, across the departmental divide, the Welsh Development Agency, Scottish Enterprise and the Industrial Development Board for Northern Ireland.

[2] Dr Robinson gave evidence twice: in February on behalf of the DTI, and again in June having left the DTI to resume his former work as Research Director for IBM (UK).

CHAPTER 3 BALANCE OF ADVANTAGE

3.1 The main concern of those who are suspicious of international investment in UK science is, "overseas exploitation of United Kingdom brains" (Q79). "Exploitation" is of course ambiguous. Exploitation is welcome in the non-pejorative sense, ie constructive use on reasonable terms; what would be unwelcome would be exploitation in the pejorative sense, ie use on terms which favoured the exploiter to the disadvantage of the UK.

UNIVERSITY OVERHEADS AND INTELLECTUAL PROPERTY

3.2 One way for overseas interests to exploit British brains is to make a research contract with a British university, in which the university charges too little, or surrenders too much of the "intellectual property" (knowledge capable of being published, patented or otherwise exploited) arising from the work, or both. Both costing and intellectual property rights (IPR) are now the subject of guidance by the Committee of Vice-Chancellors and Principals (CVCP)[1] and there are explicit IPR policies in most universities; but the terms and price of each contract are ultimately matters for negotiation case by case. A university might of course make a bad deal with any company, foreign or British. It might be argued, however, that a bad deal with an overseas company, in addition to disadvantaging the university, robs the United Kingdom of the fruits of the investment of public funds in the science base.

3.3 The Chairman of the CVCP (Q392) is not aware of any university which explicitly prices research higher for international customers. He summed up general pricing policy by saying, "We do the best deal that we can" (Q393; cp p9, Q46).

3.4 Oxford University explained their pricing and IPR policies to us in some detail (p8, Q46). "The question of ownership of intellectual property is inextricably linked to the level of funding [by the sponsor/customer]". The University normally seeks to retain IPR[2], granting a sole licence to the sponsoring company in return for royalties. As to pricing, their starting-point is to cost overheads (indirect costs) at 42 per cent of direct costs (mainly salaries).

3.5 A distinction may be made between "foreground" intellectual property, being the outcome of a particular project, and "background" or "core" intellectual property, the knowledge base out of which future projects may develop. The MRC told us, "The research team which allows its core research and intellectual property to pass under the control of one company may, in the long run, deny itself opportunities for support from other companies" (p204). This is an important observation, which any research group would do well to bear in mind.

3.6 Oxford University explained to us why they aim to retain all IPR, whether background or foreground:

> "..."foreground" intellectual property arising from a project becomes "background" to a later project which builds upon the earlier results. In many cases the exploitation of this "foreground" also requires access for commercial purposes to the "background". If the "background" has been assigned by the University to a third party, perhaps to a marketplace competitor of the company interested in supporting the later project, access is likely to be denied. As an increasing amount of research is carried out in collaboration with industry this is becoming a serious problem. The end result, if assignment of "mainstream" intellectual property is made, will be that the University has lost some freedom of action, which is potentially damaging to future research programmes" (p8; cp Q151).

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[1] *Costing of research and projects in universities: report and guidance for universities*, CVCP 1988; *Sponsored university research: recommendations and guidance on contract issues*, CVCP 1992.

[2] In the special case of pharmaceuticals, the companies tend to seek ownership of IPR (for reasons explained to us by the ABPI, QQ224-5), and the University usually agrees, subject to reasonable royalties.

3.7 Imperial College aim to drive a harder bargain than Oxford and most other universities (p3, Q46). They prefer non-exclusive licensing, and charge more for an exclusive licence ("surrender of intellectual property thus has a price tag"); and they cost overheads at 110 per cent of direct staff costs.

3.8 As to whether in practice these policies result in a fair return to the university and the taxpayer for international investment in UK academic science, our witnesses offer a broad range of opinions. At the optimistic end of the range stands Ian Harvey, Chief Executive of British Technology Group Ltd (p227). He argues that it is a mistake to worry about "losing exploitable intellectual property": if an idea can be exploited, it will be exploited, either under licence or not. What matters is to secure income through licensing, and, he reports, "The UK is very good at generating value from intellectual property", being "roughly equivalent to the US in terms of dollars of revenue generated per dollar of research and development spend". He adds that in many multinational companies, IPR acquired in the UK earn "internal royalties" for the UK subsidiary; and that "foreign companies, particularly the Japanese, are often surprisingly generous in permitting ownership [of IPR] by their collaborators".

3.9 Mr Harvey's optimism appears to be shared at Imperial College. In their experience (p3), overseas companies investing in UK science are not generally looking for results which will be exploitable in the short term, and therefore do not deprive British industry of "intellectual property of significant commercial value"; perhaps for the same reason, they are usually "more relaxed" about the College's policy of non-exclusive licensing than British sponsors. By contrast (Q46, cp p273), "some UK companies...show a resistance to being driven up the learning curve of paying full overheads".

3.10 Professor Colin Besant, the College's Professor of Computer-Aided Manufacture, whose section is almost fully funded from overseas grants (Q576), acknowledged some substantial infrastructure investments from overseas; but he reported that "the Japanese are quite tough to negotiate with in terms of getting access to our intellectual property", and that many overseas countries appear to be "after the intellectual property so they know how to make things and then I feel they are going to chop our industries away". However, he is having "more success in dealing with overseas companies than British companies in the area of intellectual property" (Q567).

3.11 Witnesses from Oxford University have also found (Q18) that, in general, overseas companies are less interested in IPR than British sponsors, and more in "improving their own in-house technical expertise" and opportunities for training and recruitment. However, they consider (p8) that "on the whole, British universities sell their research cheaply". They present this as conscious policy, enabling the university to do research of its own choice. This is the line taken by the Chairman of the CVCP (Q399): "I think that there is a considerable subsidy on many contracts, but that is a decision to be made...it is an academic and a market decision". Dr Webster, on the other hand (Q151), considers that most universities are undercharging (though he cites Imperial College as an exception). The Principal of the University of Swansea (Q590) reports that, whereas full cost recovery would require overheads of more than 100 per cent of direct staff costs, his university achieves an average of only 60 per cent; he blames this on the individual researchers negotiating the contracts, who would "sign away their birthright" for the salary of a research assistant.

3.12 Mr Peter Raymond, the Managing Director of UMIST Ventures Ltd, a company established by UMIST to exploit IPR through licensing and starting up companies, described his company as

> "as much a defence mechanism as anything else because it is very hard now to negotiate serious income-generating relationships with the serious sponsors of research. They want access to our brains, they want access to our technology, a lot of which is funded from the British taxpayer, and they want to take it away, add value to it and sell products at a higher value to our disadvantage" (Q282).

By way of contrast, witnesses with an industrial background told us that universities are now overcharging, and being "over-zealous" in seeking the maximum cash return for IPR (QQ615-6; cp British Gas p226).

3.13 Differences between our witnesses as to the costing and pricing of university research are continued in the evidence which we have received concerning the attitude of overseas investors. As recorded above, BTG, Imperial College and Oxford University generally find overseas sponsors more generous in negotiation than British firms; according to Oxford (p7), the universities' "sophisticated approach to the protection of IPR", which they attribute to the first-to-file patent system, actually attracts overseas investors. On the other hand, the Vice-Chancellor of the University of East Anglia told us that overseas companies expect to pay no more than British companies, which consider that they have already contributed to university overheads through taxation (Q399); and the Principal of Swansea University (Q576) has experienced difficulty in securing from overseas companies an overhead that represents the cost of the "resource base" built up by British public and private funds.

3.14 It should be remembered that a patent is not a licence to print money. According to Dr Webster (Q131), some universities' attitude currently amounts to "Let's rush into patenting because we are going to make lots of money"; yet current research suggests that "in terms of generating income for universities, there is not a strong or necessary correlation between the number of patents one holds and the actual licensing or royalties you can generate subsequently on the market. Many patents languish; many patents are not taken up for commercial use...". The House of Commons Science and Technology Committee, in the course of their enquiry into *The Routes through which the Science Base is translated into Innovative and Competitive Technology* (HC 74), found a wide variation in the income of universities from patents and royalties (paragraph 118):

> "Edinburgh received over £3,500,000 on royalties in 1992-93, mostly from one licence. Warwick received only £183,226 in 1992-93 and Heriot-Watt only £20,000, even though both these universities receive an income from industry that is roughly comparable with Edinburgh's".

Equally, it cannot be assumed that assignment or exclusive licence to a UK company will necessarily ensure manufacture of the end product in the UK, since the licensor may make a partnership with a non-UK firm.

Long-term Funding

3.15 The evidence reviewed above tends to suggest that overseas investors in the UK science base are, on the whole, less interested in securing exploitable IPR than British investors. This conforms with evidence that, in general, international investment in the science base tends to be on a longer time scale than British investment, and tends to involve research of a more fundamental character, with less emphasis on commercial exploitation of results in the short term. Our present enquiry began with strong statements to this effect from Oxford University and Imperial College.

> "...In general it appears that overseas companies are prepared to support longer range research projects whereas UK companies tend to support only research nearer the market-place. A number of overseas organisations sponsoring research at Imperial College have indicated their willingness to support work which they judge is unlikely to produce results which can be turned into commercial products or processes within less than five to ten years. It has to be said that in general UK companies concentrate their support on research with shorter term commercial potential" (Imperial College, p2).

3.16 Professor Howard Thomas, Head of Medicine at the College's Medical School at St Mary's Hospital, told us (Q11) that, in biotechnology and pharmaceuticals, overseas companies will often commit themselves for 3-5 years whereas British companies will often commit themselves for only one. Mrs June Clark, Director of Oxford University's Research Services Office, agreed that "large-scale, long-term research programmes" are more likely to be supported by overseas companies than by British companies (QQ17-18). Professor Igor Aleksander, Head of Imperial College's Department of Electrical and Electronic Engineering, told us how he is looking to the USA and Japan to find industrial laboratories doing fundamental research with which to collaborate; the British laboratories with which his department has collaborated since the 1890s have been in decline since the mid-1970s (QQ18-22, 30-33). The College's Pro-Rector (Research Contracts), Dr David Thomas, offered us an illustrative anecdote (Q30):

> "...a Japanese company who endowed a post at the college recently visited and talked to the researcher and asked him what he was doing. The research director of the company ended up by saying, "We are very pleased with that because it cannot have a use on the timescale of five years, but it is likely to have a commercial use between five and ten years. If it were within five years, we would already be doing it in the company"".

Similar evidence was presented to the Science and Technology Committee in the House of Commons, in the course of their enquiry into *The Routes through which the Science Base is translated into Innovative and Competitive Technology* (HC 74, paragraph 115).

3.17 Some subsequent evidence, on the other hand, suggested the contrary. Professor John Krebs, Chief Executive of the NERC, reported (Q435) that his Council's contract work is dominated by short-term problem solving for both British and international customers. The witnesses brought before us by the Royal Academy of Engineering went further (Q576): the Principal of Swansea University told us that his institution receives long-term investment from several of the biggest and best British companies, whereas some overseas companies are "out for what they can get there and then"; the Professor of Computer-Aided Manufacture at Imperial College named some British companies from which his department has received long-term investment (Rolls Royce, British Airways, British Telecom, ICL/Fujitsu - cp p272 point 3; contrast point 4).

3.18 It is no surprise that experiences differ between universities and between sectors. It is good to be reminded that there are major British companies investing in long-term research in British universities. However the balance of the evidence suggests that, taken overall and with exceptions on both sides, overseas support is more likely to be of a long-term nature than support from British industry.

OVERSEAS STUDENTS

3.19 Our witnesses are clearly of the opinion that the international investment in UK science represented by overseas students is of benefit to the host university and to the UK (pp 87, 214; QQ253, 356, 367-9, 448-451). In the short term, non-EU students bring in welcome full-cost fee income (though some are supported by UK public or private funds - see Tables A12, A14-16) and, in the case of research students, research funding from the HEFCs; and the presence of talented students and researchers (and academic staff - QQ278, 287) from overseas enriches the intellectual and cultural life of the host department and university. Our academic witnesses rightly regard this intellectual contribution as more important than the money: "We do not just want overseas students because they pay fees, we want the best ones" (Professor Clarkson, Swansea, Q594); "There is a sense in which the intellectual inward investment is more important than the financial inward investment" (Dr Jamieson, BBSRC, Q462).

3.20 In the long term, people who have studied here usually return home, where they may act as friends and even ambassadors for British science, and may pay dividends to the UK in the form of contracts or collaboration (QQ55, 253, 308, 426, 593). The British Council offer as examples the Honda wind tunnel at Imperial College, and the Sharp Laboratory in Oxford (p75). In our view this is the most important benefit of all, both to the science base and to the nation as a whole.

3.21 As to possible disbenefits, we asked the British Council whether overseas research students were taking places which could have gone to British postgraduates. They produced evidence from *An Anatomy of Research Personnel in UK Universities*, published by the SERC in

1992, to show that this was not the case (p88). The discipline in which overseas postgraduates are most visible is engineering: eg in the Department of Mechanical Engineering at Imperial College, out of 168 research students and research assistants, over 90% are from overseas (p272). According to the British Council, "Engineering professors have reported that it was difficult to find UK research students to take the awards (often provided by industry and other non-research council sources). However, there is clearly demand from overseas for postgraduate research training in engineering".

SCIENCE IS INTERNATIONAL

3.22 The House of Commons Trade and Industry Committee has recently reported on *The Competitiveness of UK Manufacturing Industry* (HC 41). The Committee notes that "manufacturing is increasingly an international activity", and that "the size of the UK manufacturing sector now depends much less on the health of UK-owned manufacturing firms, and much more on the attractions of the UK as a location for manufacturing". They conclude (paragraph 50), "The central thrust of the Government's policies for industry should be to maintain and enhance the attractiveness of the UK as a location for manufacturing and other industrial activity". In particular, those policies should be "helping to make the UK the preferred location for activities requiring the greatest skills and having the highest value-added content (for example R&D and design)".

3.23 They set this recommendation in the context of growing competition from the newly-industrialised countries (NICs) of the Far East. "The more serious challenge will come as the NICs seek to move into higher-technology areas of manufacturing...both Taiwan and South Korea clearly have a determined government-backed strategy to move into higher-technology areas, and will have some strong advantages, especially their investment in training" (paragraph 56). They conclude, "The problems affecting UK manufacturing need to be tackled *urgently* before the full effect of competition from the NICs is experienced".

3.24 This report complements *The Import and Export of Jobs: The Future for Manufacturing*, by the House of Commons Employment Committee (HC 160). That Committee too detected emerging competition in the Far East:

> "We note that the Taiwanese government is determined to increase its level of technological capability in order to attract high quality jobs to Taiwan. Having passed through a phase of rapid low-technological expansion, that country has set its sights on creating better paid jobs and therefore a higher standard of living for its population by carrying out a concerted planning effort based on considerable investment in education and scientific research expertise. All this is being done within a highly competitive, capitalist system. We consider that the UK must respond vigorously to competition from Taiwan and similar newly emerging industrialised nations" (paragraph 35).

Further on, they recommend "that the DTI examine ways in which companies could be assisted to locate relevant research expertise within the UK" (paragraph 342).

3.25 These reports serve as a warning that investment in science, and in the high-quality employment which goes with it, is now conducted at a global level. That warning was repeated for us in stark terms by witnesses representing three major international investors in UK science in the key sector of electronics: Northern Telecom's research company BNR, which has 1500 R&D staff at four locations in the UK and spends over $1m each year in UK universities; Olivetti, whose only Corporate Research Laboratory is in Cambridge; and IBM (UK), whose annual R&D spend in the UK is £145m.

3.26 For Northern Telecom (QQ668, 681), David Ball said that new market opportunities are presenting themselves in Africa and the Far East. These countries offer lower costs, and in some cases surprisingly high skills; software-based R&D is highly "portable"; and in political terms an investment in R&D can make it much easier to enter a new market. Northern Telecom has now created a critical mass of R&D capability in the UK, and will not lightly dismantle it; but the UK is now in competition for that investment with locations such as Turkey, India, Vietnam and the former Soviet Union.

3.27 Olivetti too are unlikely to uproot from Cambridge in the short term; but Dr Andy Hopper, the Director of their Laboratory, indicated (QQ693, 706) that if they were starting from scratch, they would consider seriously other locations. One contender would be the Grenoble region of France; one possible reason for preferring France to the UK would be the British Government's perceived ambivalence towards the EU.

3.28 IBM (UK) was represented by Dr Geoffrey Robinson, Director of their Hursley Park Laboratory. Dr Robinson distinguished between product development, which follows the market, and corporate research, which seeks connexions with the best researchers. IBM research in the UK is "holding its own", but new investments are likely to go to the Far East, where there are market opportunities now combined with high skills (Q693). UK universities, he said, are now in competition with researchers around the world; investment will be awarded not to the lowest bidder, but to the best scientists, and to those most willing to collaborate (Q701).

3.29 Dr Andrew Webster (Q148) made a similar point, adding that UK companies are liable to expand internationally just as much as companies based overseas:

> "We operate in a globalised economy and, in a sense, in a globalised technology too, and we have to be able to manage that as best we can within the United Kingdom and accept that there are going to be circumstances in which multi-national United Kingdom corporations are not going to invest in the UK and actually invest overseas. It is not really a question of "UK Ltd" versus everybody else, but of large corporations and how they orchestrate their affairs that we have to address - whether United Kingdom or other countries".

3.30 Another academic observer of science and innovation policy, Professor Michael Gibbons, Director of the Science Policy Research Unit (SPRU) at Sussex University, reports that recent studies by SPRU point in the same direction (p274). Multinational companies are doing more R&D abroad; this is due to "changes in the nature of competition", increases in technological knowledge, and increased demand for qualified scientists and engineers. The UK must work to secure a share of this increased investment, "to maintain the international quality of the cognate parts of the science base". "Conversely, policies which seek to preserve the "national" science base by inhibiting such investments could lead to the further weakening of UK science by starving it further of much of the resources necessary to work at the forefront of the most advanced technological areas".

3.31 Our academic witnesses have no difficulty in thinking globally:

> "Knowledge is international and universal, and research must be global. That is the general atmosphere in which we like to work" (Dr K Edwards, Vice-Chancellor of Leicester University, Chairman of the CVCP, Q346)
>
> "[International investment] enables our scientists to do more research, to do longer range research and to do it in collaboration with world players of all sorts" (Dr David Thomas, Pro Rector (Research Contracts), Imperial College, Q28)
>
> "Interchange of concepts and findings on a global scale is a prerequisite of high quality research. As stated by [Sir] Mark Richmond [former Chairman of SERC, in evidence to our enquiry into *Priorities for the Science Base*], "the international research fraternity of science is often stronger than the national one"" (Loughborough University of Technology, p263)
>
> "There are clear scientific advantages to international partnership. The scope and quality of the science is enhanced because international activities typically attract the most able

> and innovative scientists...UK science benefits from enhancements to UK facilities made possible by overseas investment which provides a higher level of service to the UK community. Furthermore, greater user pull is generated from a European and/or global market, for its ideas and innovations" (SERC, p209)
>
> "Pursuit of science and technology is increasingly conducted along international lines...The concept that science does not recognise international borders applies to the academic science base, industrial R&D and to the relationships between academia and industry...It makes no sense for the UK to attempt to ensure that all stages of development, from basic discovery to finished product, are conducted within the UK or indeed the EU" (MRC, p203)
>
> "International involvement in British science is highly desirable provided that adequate provisions are made for the protection of IPR. The opportunity for students and postdoctoral workers to study and research in an international context is of considerable importance in the development of the future skills base in science and industry in the UK" (BBSRC, p109)

3.32 We asked our witnesses from the BBSRC what they looked for from this enquiry. They replied (Q489) that the scientific community is waiting for a clear statement that it is right to seek investment in British science from outside the UK. Dr Brian Jamieson, the Deputy Chief Executive, put it thus:

> "I think we should be disappointed if there was any sense in your recommendations that we should be little Englanders and insular in any way. You might recognise the international dimension and dynamic of our science; recognise the added value that networking and the movement of scientists and ideas to and from these shores contributes; trust us through the mechanisms that we have described to be responsible in the exploitation of technology, and certainly to give British companies a fair crack of the whip, but not to discourage us from looking overseas and to trust us to spot any Trojan horses that might appear on the horizon".

3.33 On the evidence set out in this Chapter, we are happy to endorse these words. **International investment in UK public sector and industrial science is a significant invisible export in its own right; and international involvement is essential if UK science is to retain its leading-edge position across the whole range of scientific endeavour. This is especially true for those sectors in which investment by British industry is low or predominantly short-term; and it will become more important as the large companies which fund most R&D become less tied to their country of origin and more able and willing to operate internationally, and as scientific standards rise in other parts of Europe and in the newly-industrialised countries.**

3.34 **Basic science has always been global in its outlook; this perspective must not be lost as researchers look more closely at the potential of their research to create wealth. The interests of the science base and the British taxpayer must be safeguarded by full costing, prudent pricing and adequate IPR and licensing arrangements; we welcome evidence that British universities are becoming increasingly competent in these matters. But the future of British science lies in free trade, not protectionism; the UK should therefore seek to maintain the international excellence and international outlook of the science base, in order to maintain her position as preferred European location for R&D investment.** In Chapter 4 we consider a variety of ways in which international investment in UK science may be encouraged by Government action.

CHAPTER 4 POLICIES FOR INTERNATIONAL INVESTMENT IN UK SCIENCE

INTRODUCTION

4.1 The Government cannot command international investment. However, their actions can encourage and facilitate it, and on the other hand may directly or indirectly deter it. In this Chapter we offer a range of policy actions which, taken together, would signal to the science base and to business around the world that international investors in UK science, engineering and technology are welcome.

PUBLIC SECTOR SCIENCE

The Science Base

4.2 It almost goes without saying that international investment will only be attracted to British science so long as British science remains strong. In the international competition for investment in science, the strength of the UK science base is one of the UK's major advantages (see the evidence of inward investors cited in paragraph 2.19), and one not easily or quickly copied by other nations (p271). In our report *Priorities for the Science Base* (HL Paper 12, December 1993), we warmly welcomed the fresh thinking on Government support for science represented by the White Paper *Realising our potential* (Cm. 2250, May 1993). In their response to our report (Cm 2636, July 1994), the Government confirmed that they accept their role as "the main funder of basic research" (paragraph 31), and agreed that "the strength of the science and engineering base lies in its capacity to undertake long-term curiosity-driven research and to train highly skilled men and women" (paragraph 68).

4.3 This capacity depends crucially on the funds provided through the Science Budget and the research elements of the Higher Education Funding Councils' block grants (and, in the case of clinical medical research, the resources of the NHS). We expressed concern abut the level and distribution of the research element of block grant in our report of last December: we welcome the news that the "dual support transfer" (which enhanced project funding at the expense of block grant) is to be reviewed independently in the autumn of this year (Government response, paragraph 53).

4.4 We also welcome the launch in July of the Innovative Manufacturing Initiative. This initiative is to be managed by the EPSRC, with involvement from the BBSRC, the ESRC, the DTI and the OST; it is intended to match £50m per year from public funds with an equal amount from the private sector to support a multidisciplinary research programme to improve the products and processes of UK manufacturing industry.

4.5 While these developments are welcome, neither represents an increase in public funding for basic science, and we remain convinced that such an increase is necessary if UK academic science is to maintain its leading international position. We note with concern that the *Forward Look of Government-funded Science, Engineering and Technology 1994* (statistical supplement, Table 1.3.2) forecasts a fall in the Science Budget in real terms in 1995-96, and a fall in research expenditure by the HEFCs in 1994-95 (see Table 7). **We urge the Minister for Science, Mr David Hunt, to press for these figures to be revised upwards.** This is especially justified by the fact that government funding of R&D as a proportion of GDP lags way behind the comparable figures for our competitors among the industrial nations and will soon lag behind that of the faster developing nations of the Pacific rim. The future of the British economy depends upon investment in an innovative manufacturing industry, which in turn depends upon investment in the science base.

Table 7: Net Government expenditure on R & D in real terms (base 1992-93)

£ Million	1993-94	1994-95	1995-96	1996-97
OPSS/Research Councils	1048.8	1066.5	1061.2	1040.2
HEFCs	894.7	873.4	875.8	878.8

Source: Forward Look 1994, statistical supplement, Table 1.3.2.

Bilateral Initiatives

4.6 The Government have recently invested considerable effort in fostering scientific relations with Japan: see Appendix 4. Dr John Richards, Head of the British Council Science and Technology Department, put it to us that experience in fostering scientific relations with Japan might be extended to other countries (Q312) - though "target countries would need to be carefully identified and may not yield the same level or nature of benefits which collaboration with Japan has".

4.7 We agree, and are pleased to note that the *Forward Look 1994* (paragraph 6.9) refers to steps being taken to enhance collaboration with Israel and the Republic of Korea, and that the Minister for Science and the Chief Scientific Adviser visited Jordan and Israel in October. Dr Richards mentioned Korea, along with Taiwan and China (Q342); Mr Christopher Priston of the Invest in Britain Bureau told us (Q93) that investment could also be looked for from Hong Kong, Thailand, Singapore and Malaysia; Professor Arbuthnott of Strathclyde went so far as to propose an initiative to encourage the creation of academic-industrial research consortia linking the UK and the Far East (Q552). **We commend these possibilities for action by the Office of Science and Technology**. China, in particular, seems set to become, in the longer term, a leading industrial power, and is likely to expand its R&D requirements substantially in the near future.

4.8 These are, of course, some of the very same countries with whom, we noted in Chapter 3, the UK is now in competition for international investment in science. It is our hope that by creating constructive relationships now, the destructive effects of future competition may be avoided.

International Scientific Facilities

4.9 In 1991, this Committee reported on *International Scientific Programmes* (HL Paper 24), and considered among other matters the advantages and disadvantages of hosting large international scientific facilities, such as the Joint European Torus (JET) at Abingdon in Oxfordshire. Governments decide whether to offer to host such facilities by weighing costs against benefits, and it appeared to us that the Government took a rather narrow view of the possible benefits; accordingly we recommended that the Government should "do more to seek out opportunities for hosting such facilities" (paragraphs 7.16-20, 27). In their response (Cm 1629), the Government agreed that not all the possible benefits were quantifiable, but rejected the view that location in the UK should be pursued as a matter of principle; "Opportunities arise rarely and each case is assessed on its merits".

4.10 In 1993, the OST published a report, written for them by the consultants Segal Quince Wicksteed, on *Economic Impacts of Hosting International Scientific Facilities*. The report found that the host country tends to receive a high proportion of contracts to supply goods and services, most of the jobs at technician and manual level (though not scientific jobs), and spending by foreigners in the local economy, amounting to a flow into the economy of 40-70% of the facility's annual budget (not necessarily a benefit since it may displace alternative economic activity), plus tax revenues from foreign workers of 4-10% of the budget (a clear benefit). In addition, supplier companies may receive technology transfer, new skills, and an *entrée* into new markets. Scientists in the relevant subject area benefit from a raised profile for their subject, and the opportunity to meet world leaders in the field visiting the facility. These benefits must of course still be weighed against the "host country premium" and other costs.

4.11 This report appears to have encouraged the Government to take a more positive attitude to international facilities. This change of policy has been rewarded by the recent decisions of the European Molecular Biology Laboratory Council to locate its European Bioinformatics Institute in Cambridge, and of the EU to locate the European Medicines Evaluation Agency in London. (The former will comprise a data library and a strong research component, employing around 70 technical and scientific staff. The latter, though a science-based regulator rather than a scientific facility, is expected to have similar impacts - QQ104, 135; it will employ around 140 technical and scientific staff - p197).

4.12 We congratulate the Government for their part in these successes. They represent international votes of confidence in UK science, and can be expected to lead to direct investments and other indirect benefits. **We recommend that the Government should continue to seek suitable opportunities to host further international scientific facilities.**

4.13 The SERC (p210) informed us that there are international differences of opinion and practice as to whether overseas users of national scientific facilities should pay: the UK position is that they should; France and Germany maintain that they should not. We have not examined this issue, and make no recommendation.

Travel

4.14 In the same report on international scientific programmes, we noted the importance of travel funds for active researchers, and expressed concern that such funds were in short supply (paragraph 4.6-9). Well-prepared scientific travel is essential as a precursor to international investment. In hard times, the travel budget is always among the first to be cut; yet in the international world of science, travel must be regarded as an investment in excellence, not as a luxury or a perk, and the amounts of public money involved are very small when compared with the benefits, including the scope for new international investment in UK science.

4.15 Our witnesses in this enquiry have emphasised the importance of travel in the context of international investment:

> "The sales force...comprises the individual academics who make contacts round the world" (Dr David Thomas, Pro-Rector (Research Contracts), Imperial College, Q9)
>
> "It is a body-contact sport" (Dr Geoffrey Robinson, Chief Adviser on Science and Technology to the DTI, Q106)
>
> "The individual going out is all-important. That is where the research contact will be made" (Professor B Fender, Vice-Chancellor, Keele University, Q372)

Anecdotal evidence suggests that universities and the NHS are in fact finding it increasingly difficult to allocate funds to enable their staff to travel.

4.16 We have heard from the three principal organisations in receipt of public funds which help British scientists to travel. The Royal Society (Q614), through its exchange and fellowship schemes, sponsored 1,372 exchanges in 1992-93, mostly to Europe and Israel (417) and the former Soviet Union (378), some to China and Hong Kong (179), Australasia (104) and Japan (81), and small numbers to Latin America, the Indian subcontinent, Canada, the Far East and other countries. It also dispensed over £1m in travel grants to individuals, or to groups travelling to meetings overseas; according to the Society's Annual Report, "A review of the [travel grant] scheme confirmed its importance in the exchange of ideas across national boundaries". The Society's total grant-in-aid for international relations, travel and exchanges in 1992-93 was £5.2m.

4.17 The Royal Academy of Engineering in 1992-93 made 290 international travel grants, enabling graduate engineers to travel to 35 different countries for conferences or collaborative research. They also made grants enabling 163 engineering undergraduates to travel to Europe for study, research or industrial placements. Professor Besant told us (Q564),

> "...the Royal Academy does provide a marvellous grapevine around the world to link engineers both from industry and universities with their counterparts in various countries around the world, and I think that is an extremely valuable role and obviously contracts do flow from those contacts. I myself visit Far Eastern countries a great deal, countries like Indonesia, Korea, Japan, Taiwan and so on, and generally through the links of the Royal Academy and through the Imperial College grapevine I usually get received at ministerial level when I go to these countries and of course it is marvellous from the point of view of linking and being able to link British industry in with industry from countries in the Far East".

The Academy's grant-in-aid for overseas secondments, travel and external affairs in 1994-95 is £484,000.

4.18 "The British Council works to initiate, encourage and develop research and other professional contacts and collaborations between the UK and other countries" (p75), and spends about £100m per year (Q319) in doing so by a variety of means:

(i) *Joint Research Programmes* These programmes encourage collaboration in areas of mutual interest, with priority to projects likely to attract further funding from other sources. Matching funds are provided by a national body in the partner country. Awards are competitive, and excellence is a key criterion; they are intended to contribute to travel and subsistence costs, but not direct research costs such as bench fees and consumables. The Council currently has 10 western European JRPs (p78), plus programmes with Poland and Japan.

(ii) *One-off actions* Exchanges, travel grants, fellowships and bilateral specialist meetings, all with a view to encouraging research collaboration.

(iii) *Higher Education Links* This scheme promotes collaboration with higher education institutions in countries supported by the aid budget and in subject areas relevant to development, most of which are scientific (p79). The Council administers it on behalf of the ODA, whose annual contribution is £3m; the UK universities are represented by the Committee for International Co-operation in Higher Education. "The balance of benefit is intended to favour the overseas institution, but the UK institution may also benefit through staff development, increased recognition and access to unique research data and environments".

(iv) *Education Counselling Service* This service encourages people from selected countries (Q339) to come to the UK as overseas students.

The Council also plays an important enabling role in the teaching of English as a foreign language.

4.19 We commend the work of the Royal Society, the Royal Academy of Engineering, the ODA and the British Council in this regard; **we trust that the Government will at least maintain funding for this important aspect of their work**.

Overseas Students

4.20 The evidence set out in Chapter 3 shows that UK science derives both short-term and long-term benefits from the presence of overseas students in our universities; yet the figures given in Chapter 2 show that, in the keen competition to attract overseas students, the UK is in danger of falling behind.

4.21 This must be due partly to the Government's decision in 1979 that non-EU students should be charged full-cost fees, and it is tempting to recommend that this decision be reconsidered. However we acknowledge that this would be unrealistic, particularly at a time when funds to support home students are stretched beyond the limit; and it must be admitted that, so long as a reasonable number of overseas students is found who are willing or able to pay full-cost fees, they are a very welcome source of university income. We are confident that the education, training and research opportunities available to overseas science students in UK universities are worth every penny of the fee: but this is a market. The universities **must maintain a high quality if they are to continue to receive a high price, and a quality which will stand international comparison if they are to retain and increase their market share.** Monitoring quality is a crucial matter for the universities themselves to consider.

4.22 We note the importance to British universities of overseas students from the Far East, particularly Malaysia, Hong Kong, Singapore, China and Taiwan. These countries are particularly important since, according to the DTI (Q93), they are among the "Asian tigers" from whom the next wave of inward investment may be expected. We also note the emerging competition from Australia and Japan. The facts of geography give those countries a natural advantage in attracting students from around the Pacific rim; British universities will have to fight hard to retain their "market share". **We urge the Government to support the efforts of the universities to maintain this country's position as the European destination of first choice for travelling students from these key countries; in particular, we recommend that consideration be given to the position of students from Hong Kong wishing to study in Britain after 1997.**

4.23 We note with approval the range of publicly-funded assistance available to outstanding overseas students coming to the UK from both developed and developing countries. **We recommend that the Government assure themselves that what this country offers by way of scholarships etc for overseas students stands comparison with the policies of our principal competitors, in particular France and Germany.**

4.24 The one concern expressed by our witnesses is over what Mr Raymond of UMIST Ventures Ltd (Q305) called "feeding the competition". In academic terms, postgraduates trained in the UK may return home to build up the science base of their own country, thereby reducing the competitive advantage of British universities. We have been told that in China (Q304) and Malaysia (Q261) this is national policy, and also that "the Japanese and Korean institutions are particularly vigorous in monitoring the progress of their students" (p273). The Royal Academy of Engineering (QQ592-6) report that the same can happen in industrial terms: a British company collaborating with a university department may find that its know-how and even intellectual property "leaks" through overseas students to an overseas competitor. Professor Besant of Imperial College told us that some companies demand an area of restricted access within the department, and specific contracts for staff and students: "This does not go well sometimes with the ethics of scholarship within the university, and it does concern me, but we are getting forced in that direction". Dr Andrew Webster described a comparable arrangement in the pharmaceutical sector, whereby a company may allow a department to have access to new compounds under development, on condition of secrecy (Q122).

4.25 A distinct but related issue concerns the possible role of overseas students from certain countries as channels of technologies which might contribute to weapons of mass destruction. Mr Tim Boswell MP, Parliamentary Under-Secretary of State at the Department for Education, told the House of Commons on 19 July 1994 (*Hansard* col 137) that "The Government have agreed [with the CVCP] to provide information and guidance to the universities and colleges on the countries and technologies of concern".

4.26 With this exception, we consider those who regard overseas students as a form of academic or industrial spy to be wholly misguided; if such students did not expect to leave the UK knowing more than when they came, they would not come at all. The creation of restricted access areas (other than for security of, for example, expensive or sensitive equipment) would seem to us to be destructive of academic openness; openness is fundamental to the nature of the university, and one of the characteristics of British universities which is most attractive to international investors and foreign students alike. On the other hand, we recognise the real concern of companies in this area, and the growing importance of academic-industry relations.

4.27 **We recommend that the Committee of Vice-Chancellors and Principals consider the desirability of drawing up guidance for firms and departments upon how to handle sensitive know-how and information during a contract or collaboration, while preserving academic openness.** As a starting-point, we suggest that confidentiality may be an appropriate condition to include in a full-cost commercial research contract; but that where the work in question is significantly supported by public or charitable funds, or involves students, openness should be the rule. The same principles should apply whether the industrial partner is of overseas or domestic origin.

The Diplomatic Service and the British Council

4.28 The Diplomatic Service has a role in promoting British science overseas and encouraging international collaboration and inward investment. The British Embassies in Bonn, Paris, Moscow, Rome, Tokyo and Washington have science and technology sections, with between one and three staff. The tasks of these sections are various, but their core activities as set out for us by the Foreign Office (p192) include:

- "Establishing regular and efficient direct channels of communication between the UK, the host scientific community, and officials to help preserve the depth and vitality of the UK's S&T relations with the country in question...

- Informing Government Departments of opportunities for scientific collaboration in a wide range of fields. Identification of potential foreign investors in the UK."

Their importance to the DTI's new Overseas Technical Information Service has already been mentioned (paragraph 2.35).

4.29 International investment in UK science is also encouraged by 33 staff working full-time on inward investment in the USA, Canada, Japan, Germany, Switzerland, Korea and Taiwan, as well as by other staff in smaller markets. As an example of a recent success, the Foreign Office cite the decision of the European Molecular Biology Laboratory to locate the European Bioinformatics Institute in Cambridge, against bids from Germany and Sweden.

4.30 The British Council also has specialist Science Officers working overseas to identify opportunities for British science. Their network is wider than that of the Foreign Office Science Counsellors; their work complements that of the Embassies, and of universities and other bodies engaged in self-promotion (Q329). One success due in part to the work of their Tokyo office is the provision by the Japanese National Laboratory for High Energy Physics (KEK) of an advanced neutron spectrometer, built in the UK, for the ISIS neutron spallation source at the Rutherford Appleton Laboratory[1]: the Council supported the initial exchanges between the British and Japanese professors involved, and the negotiation of the final agreement (p75).

4.31 The work of the Embassy Science Sections and British Council Science Officers is currently under review by the Foreign Office, the OST and the DTI, with assistance from Segal Quince Wicksteed. We note with approval that the list of "customers" consulted includes the universities and the research councils. For the British Council, Mr Bowers told us, "It is clear that we have to clarify our own role in relation to other agencies"; he added (footnote to Q330) that he hoped that the review would offer guidance and good practice, to improve service and effectiveness.

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[1] KEK pay for construction (£1.2m), running costs and some manpower; in return, Japanese scientists get beam time on any of the ISIS instruments, subject to peer review (information from SERC).

4.32 The outcome of the review is expected to coincide with the publication of this report; we hope that the outcome will be positive. Guidance, good practice and clarification of roles will be welcome; redeployment may be justified; but **we will look with concern upon any recommendation to reduce the overall science effort of the Diplomatic Service.** We have already noted above the importance of well-prepared scientific travel; the success of such travel may depend heavily on men and women on the ground, in a position to make the crucial first contact, to facilitate travel and negotiation, and to help in crossing what are sometimes substantial cultural barriers.

Higher Education Funding Formulae

4.33 It has been put to us that the way in which the Higher Education Funding Councils (HEFCs) currently determine the research element ("R") of each university's annual block grant militates against industrial investment in general, and international investment in particular. Each HEFC determines R by applying its funding formula to, among other things, the results of the Research Assessment Exercise, which was last carried out in 1992 and is due to be repeated in 1996.

4.34 According to Loughborough University (p266), the 1992 Exercise was "very narrowly restricted to basic and strategic research". This resulted in low ratings for departments whose best research was applied or near-market. This has resource implications; and Loughborough report that it has caused "major problems" in their dealings with overseas governments, as a result of which "we have lost work (students and research projects)".

4.35 Professor Clarkson of Swansea University, speaking for the Royal Academy of Engineering (Q586), raised a related issue: the 1992 Exercise created a "pressure to publish, and that does not necessarily sit well with the idea of exploiting where you may want to keep things quiet for a while". This affects relations with industry generally, not only with overseas investors.

4.36 In June the HEFCs published Circular RAE 96 1/94, on the Research Assessment Exercise 1996. This indicates two important changes from the method of the 1992 Exercise:

> "11...In accordance with the Government's policy for publicly-funded research set out in the science and technology White Paper *Realising our Potential* (Cm 2250), panels will be instructed to give full recognition to work of direct relevance to the needs of commerce and industry, as well as to the public and voluntary sectors. All research, whether applied or basic/strategic, will be given equal weight: panels will be concerned only with the quality of the work submitted for review"
>
> "24...submissions will not be required to include a summary count of publications and other forms of assessable output for each member of staff submitted. In deciding to discontinue the publication count, the funding bodies wish to signal clearly that the RAE is concerned with research quality, and that the number of publications and other forms of assessable output is not considered necessarily to be an indicator of research quality".

4.37 These changes will affect more than international investment, and we reserve judgement as to whether their overall impact will prove beneficial in the longer term; but they will at any rate address the problems identified by Loughborough and the Royal Academy of Engineering, and **we commend them as a useful first step**.

4.38 In discussion with our witnesses from the CVCP (Q386), it was suggested that the HEFC funding formulae might be altered to give specific rewards to universities which attract international investment. On consideration, we do not recommend this. The formulae take account of research students and external research income; giving either more or less weight to income or students from overseas, even if the difficulties of definition could be overcome, would amount to either a subsidy or a penalty for foreign investors, neither of which would be justified.

University Research Contracts

4.39 The very varied experiences of our university witnesses in negotiating overheads and IPR, as recounted in Chapter 3, present a picture of a vigorous international marketplace, in which some traders are naturally more successful than others. We commend the CVCP for offering guidance without attempting to control the market. We are however concerned by suggestions (QQ399, 590) that Government departments, as customers for university research, are paying less than full economic costs. This not only short-changes the universities; it also weakens their position in negotiating prices with companies both at home and abroad. **We recommend that the CVCP, in consultation with the Treasury, should devise a standard formula for costing and pricing research contracted from a university by a government department, and a means of enforcing it.**

Research Councils and Technology Foresight

4.40 Since the Science White Paper, the Research Councils are encouraged to give a higher priority to supporting research of interest to industry and other "user communities"; and a Technology Foresight programme has been set up "to produce a better match between publicly-funded strategic research and the needs of industry and other users of research outputs" (*Realising our potential*, paragraph 2.24). Speaking for IBM (UK), Dr Geoffrey Robinson suggested that the Research Councils should give particular priority to research likely to attract industrial interest around the world (Q704); yet when he addressed us for the DTI (Q95), he told us that international companies will be involved in Foresight only to the extent to which they conduct R&D in the UK (cp p261). Similarly, the new missions of the Research Councils commit them to "enhancing the UK's industrial competitiveness and quality of life"; "It is clear that this mission would be unlikely to be fulfilled if the majority of British science were directed by overseas investors" (Matra Marconi Space, p245).

4.41 As we noted in Chapter 3, most forms of international investment do not in any sense "direct" UK basic research; that is left to the academic team leaders, who remain free to seek public or even private sector support for other work depending on the same "core" IPR (see paragraph 3.5). The UK manufacturing base has been contracting for most of the century; the science base continues to aspire to excellence across the whole range of international scientific endeavour. In this situation it is desirable and indeed inevitable that some of the output of UK science with industrial applications should have its main "user communities" outside the UK. **We urge the Technology Foresight teams, and the Research Councils, to give due weight to research which may be of interest to users worldwide, even though it may not have a supporter currently located in the UK.**

Efficiency Unit Scrutiny of Public Sector Research Establishments

4.42 Ministers are currently preparing their response to the report published in June by the Government's Efficiency Unit following a scrutiny of 53 public sector research establishments: 23 research council institutes and laboratories, and 30 owned by government departments or other bodies. The purpose of the scrutiny was to consider the scope for rationalisation or changes to ownership and financing arrangements, including the possibility of privatisation. Several of our witnesses expressed concern about the impact of such changes on the establishments' capacity to attract international investment (QQ423-6, 493-4, 546, 556).

4.43 We shall be giving separate consideration to the Efficiency Unit scrutiny of Public Sector Research Establishments in our next report. We merely note here that **the Government must bear in mind the need to preserve the international standing of their research establishments when contemplating changes**. As noted above, science is international; changes which made it harder for an establishment to operate internationally would damage its science. The then Minister of State for Defence Procurement, Jonathan Aitken MP, told us in the course of our enquiry into the Defence Research Agency (19 May 1994, Q861, HL Paper 24-II) that privatisation of the DRA was ruled out for several reasons which included the need to retain the confidence of international collaborators, particularly in respect of secret research; we suggest that the same principle applies even when secrecy is not an issue.

INDUSTRIAL SCIENCE

Regulation of Scientific Activities

4.44 Many of the routine activities of science are now regulated by Government, in the light of considerations of ethics (eg controls on use of animals, or foetal material, for experiments), health and safety (eg regulations governing the handling of dangerous substances), or environmental protection (eg controls on emissions). The impact of regulation on scientific activity varies, from encouraging it (eg NERC Q431: "both UK industry and the UK Government, in wishing to respond to environmental regulations from Brussels, need to have a sound scientific base"), through making it more expensive (Q389), to prohibiting it altogether in this country or the EU, which may have the effect of driving it overseas.

4.45 The area of regulation which is currently of greatest concern is the control of biotechnology. Biotechnology is one of the principal areas of growth in science and industry today, and British scientists and companies are among those in the forefront of developments. Yet the techniques and products of biotechnology raise ethical and environmental questions, and are subject to regulation throughout the western world. Differences in how these regulations are formulated and applied are affecting the rate of scientific progress and the contours of the industrial playing-field.

4.46 We examined this matter last year, and our report *Regulation of the UK Biotechnology Industry and Global Competitiveness* (HL Paper 80) concluded that biotechnology in the UK was over-regulated, placing it at a disadvantage when compared with the USA and Japan, and even with some countries of the EU. In particular, we received evidence that over-regulation had already "stifled" biotechnology research in Germany, and might be beginning to have the same effect in the UK (paragraphs 5.71-77). We recommended improvements to UK and EU regulations, intended to reduce the burden on industry while preserving necessary protection.

4.47 The Government's response to our report (Cm 2528) was positive, and indicated that many of the changes we called for were already in hand. In the course of the present enquiry, we have been pleased to hear from Professor Dick Flavell of the BBSRC John Innes Centre (Q477) that "the efficiency and streamlining with which cases are now handled in the United Kingdom have improved...very considerably". Professor Flavell told us of a recent application for field release of genetically modified oilseed rape from a Belgian company:

> "...I am quite confident that the reason that they chose the United Kingdom committee and system to evaluate this release first is because in the last nine months there has been a substantial improvement in the ease with which one can deal with and operate through the United Kingdom systems".

4.48 On the other hand, Professor Arbuthnott of Strathclyde told us (Q547) of evidence that certain pharmaceutical companies "are becoming impatient with these European bureaucratic rules and...are moving their research out of Europe, not just out of the United Kingdom".

4.49 We congratulate the Government for modifying the biotechnology regulations in time to prevent them from stifling UK science, and industry, in this vital sector. **We urge them to keep the regulation of biotechnology and other scientific activities under review as science progresses, and to ensure that, if in any respect the UK/EU regime is stricter than that in any major competitor country, this can be fully and explicitly justified.** We shall be on the look-out for other regulations which appear to militate against international investment in UK science.

Access to Government Funding

4.50 Firms investing in R&D are in some circumstances eligible for various forms of Government support: in particular from the DTI Innovation and Technology Support Budget, and the Whitehall-wide LINK initiative (for academic-industry collaborations) now run by the OST.

4.51 We asked the Government under what circumstances foreign firms are eligible for support from the UK taxpayer in these ways. The DTI explained (Q94) that foreign-owned firms may receive DTI support on condition that they have research and manufacturing facilities in the UK, that the work supported is done in the UK, and that any exploitation of the results within five years is done within the EU. The OST told us (p199) that similar conditions apply to LINK, with the added condition that there must be "a clear and significant net balance of advantage for the UK".

4.52 These policies conform with general DTI policy, which Lord Strathclyde expressed thus on his recent visit to Japan: "Our approach is that all companies based in Britain are treated as UK enterprises whose interests within the EC we seek to promote and develop" (press notice). This policy seems to us to acknowledge the increasing internationalisation of industry, and to encourage international investment in UK science. **We commend Government initiatives in this regard, and trust that they will be further developed.**

Regional Policy

4.53 The Welsh Office promotes inward investment in general, and inward investment involving science in particular, "because of the quality of the employment it provides and because of its potential for future growth" (p200). They recognise "the importance that major companies attach to being close to universities and colleges of international standing in the research field. For this reason, the Higher Education Funding Council for Wales (HEFCW) has been charged with the responsibility of working with institutions in Wales to raise the quality of research". The HEFCW (p213) is doing this in two ways: by employing a funding formula which is slightly biased in favour of 3-rated departments, in order to "secure a platform for development" (Circular W93/10 HE, May 1993); and by distributing additional funds provided by the Welsh Office (£2.2m in 1993-94, £2.8m in 1994-95) by means of a competition for plans to raise the quality of research (without reference to research content) - the Research Quality Initiative.

4.54 The Welsh Development Agency (WDA, p220) presented us with an array of initiatives to promote inward investment in R&D in Wales: specialist staff; pump-priming grants and support for academic "Centres of Expertise"; target companies and sectors; publications; science parks (including Imperial Park, a joint venture involving the WDA, Imperial College and Newport Borough Council) and "technopoles" (supported by the EU SPRINT programme); European offices in Brussels and Wales, and partnerships with other European regions to encourage research collaborations.

4.55 According to the Welsh Office, "Overseas involvement in science in Wales remains relatively limited, but interest would appear to be growing". Recent investments include Proctor and Gamble's support for the Cardiff Common Cold and Nasal Research Centre, the establishment by Calsonic of a European Technology Centre, research by Sony into digital TV, and use of wing panel design software at the Cardiff School of Engineering by Boeing, Rockwell and Northrop, with support from NASA. The Chairman of the CVCP confirmed to us that these activities have benefited the Welsh universities (Q381); their success was also acknowledged by Professor Clarkson of Swansea, speaking for the Royal Academy of Engineering (QQ581, 602).

4.56 By contrast, our academic witnesses expressed dissatisfaction with regional policy in England and Scotland. Witnesses from the Committee of Scottish Higher Education Principals insisted on the distinctness of the Scottish higher education sector (QQ540, 544), and gave examples of successes in attracting international investment: Syntex on the Heriot-Watt research park, the relocation of Digital Equipment Ltd's high end product range from Galway in the Republic of Ireland to Ayr in Scotland, and the new European intensive computing centre with a

Cray Supercomputer in Edinburgh. The Principals, however, did not feel that they were adequately supported by Scottish Enterprise (QQ538, 541, 544, 549).

4.57 This may reflect a failure of communication rather than a problem of substance. Scottish Enterprise (and its predecessor, the Scottish Development Agency) has invested £91.7m in science and technology policies since 1982, including science parks in Glasgow, Aberdeen, Stirling, Dundee and St Andrew's and a technopole in Edinburgh; Centres of Excellence including the Scottish Assembly Technologies Centre at Napier University, the Petroleum Science and Technology Institute in Aberdeen and the Edinburgh Supercomputer Facility mentioned above; a Euroinformation Centre in Glasgow; the Academic Software Initiative, aimed at matching academic software ideas and projects with industry's needs; and innovation forums for industry in the sectors of electronics, oil and gas, optoelectronics and biotechnology (p217).

4.58 England does not have a regional development body below the level of the DTI, equivalent to Scottish Enterprise or the WDA, and the Vice-Chancellors brought before us by the CVCP indicated that they feel the lack. Dr Edwards of Leicester University described difficulties in co-ordinating the decisions of the local development corporation and the two tiers of local government, currently exacerbated by "blight" arising from local government reform (Q374). Professor Fender of Keele University, pointing to the lack of any relationship between university block grants and the population served, called for "a partnership between higher education and the region which encourages both manufacturing investment on the one hand and research investment on the other" (QQ376-8).

4.59 Here too our witnesses may be painting too dark a picture. Recent successes drawn to our attention by the DTI's Invest in Britain Bureau (p215) include Ford's new investment of £14m in a Cold Development Centre and a Mileage Accumulation Centre at its research centre in Dunton; a research centre set up in Plymouth by Vidamed of California in 1993, close to Derriford Hospital and the University of Plymouth's postgraduate medical school; and the new European Headquarters of ClinTrials, a US company which conducts clinical trials, in Maidenhead.

4.60 The Industrial Development Board of the Northern Ireland Department of Economic Development (p221) "is particularly keen to attract investment involving R&D functions, science and technology". Recent successes include the establishment of R&D centres in Londonderry by two US firms, Seagate Technology and Du Pont; and the attraction of £10.5m from the EU STRIDE programme for twelve infrastructure projects. In 1992 the DED set up the Industrial Research and Technology Unit, to promote industrial R&D, technology transfer and academic-industry relations. The IRTU provides inward and indigenous investors with support for pre-competitive R&D, product and process development, and technology and environmental audit; it spent £14m in 1993-94. The importance of inward investment in R&D is also recognised by the Northern Ireland Department of Education and Higher Education Council; and the IDB routinely introduces serious potential investors to the university network, which "has a very positive impact on convincing the investor about the science and technology credentials of Northern Ireland".

4.61 It is evident that the main concern of the regional development bodies is to attract industrial investment and create employment. Nonetheless we are impressed with their evident awareness that a strong local science base can be an important attraction to investors from elsewhere. We commend to the Scottish, Welsh and Northern Ireland Offices, and the DTI, an idea which arose in discussion with the CVCP (QQ385-6): **pump-priming funding for developments aimed at attracting international investment in science, awarded by competition among university departments on the basis of a business case.** Such a scheme would combine the virtues of the HEFCW's Research Quality Initiative and "Centres of Expertise/Excellence".

Taxation

4.62 We pressed the case for tax incentives for R&D in *Innovation in Manufacturing Industry* (1st Report, 1990-91, HL Paper 18), and the Government rejected it; we have not changed our mind, and we do not suppose that they have either. However company taxation can affect the attractiveness of the United Kingdom as a location for R&D. Given the benefits of R&D to the general economy, **we recommend that the Inland Revenue should be particularly careful, in devising and administering company taxation and in conducting their current Industrial Finance Initiative, that they do not inadvertently create incentives to place R&D outside this country.** We commend to their attention the report *Innovation and the Tax System* by ACOST, published in July (ISBN 0 11 430102 6).

CHAPTER 5 SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

GENERAL

5.1 International investment in UK public sector and industrial science is a significant invisible export in its own right; and international involvement is essential if UK science is to retain its leading-edge position across the whole range of scientific endeavour. This is especially true for those sectors in which investment by British industry is low or predominantly short-term; and it will become more important as the large companies which fund most R&D become less tied to their country of origin and more able and willing to operate internationally, and as scientific standards rise in other parts of Europe and in the newly-industrialised countries.

5.2 Basic science has always been global in its outlook; this perspective must not be lost as researchers look more closely at the potential of their research to create wealth. The interests of the science base and the British taxpayer must be safeguarded by full costing, prudent pricing and adequate IPR and licensing arrangements; we welcome evidence that British universities are becoming increasingly competent in these matters. But the future of British science lies in free trade, not protectionism; the UK should therefore seek to maintain the international excellence and international outlook of the science base, in order to maintain her position as preferred European location for R&D investment (paragraphs 3.33-34).

PUBLIC SECTOR SCIENCE

Recommendations to Government

5.3 International investment will only be attracted to British science so long as British science remains strong. We urge the Minister for Science to press for the planning figures for the Science Budget and research expenditure by the HEFCs to be revised upwards (paragraph 4.5).

5.4 The Office of Science and Technology should extend the Government's bilateral initiatives for scientific relations with Japan to other countries around the Pacific, and encourage academic-industrial research consortia linking the UK and the Far East (paragraph 4.7).

5.5 The Government should continue to seek suitable opportunities to host further international scientific facilities (paragraph 4.12).

5.6 The Government should at least maintain funding for the work of the Royal Society, the Royal Academy of Engineering, the ODA and the British Council in supporting and facilitating travel overseas by British scientists (paragraph 4.19).

5.7 The Government should support the efforts of the universities to maintain this country's position as the European destination of first choice for travelling students from key countries in the Far East; in particular, consideration should be given to the position of students from Hong Kong wishing to study in Britain after 1997 (paragraph 4.22). The Government should assure themselves that what this country offers by way of scholarships etc for overseas students stands comparison with the policies of our principal competitors, in particular France and Germany (paragraph 4.23).

5.8 We will look with concern upon any recommendation to reduce the overall science effort of the Diplomatic Service (paragraph 4.32).

5.9 We do not recommend giving special weight to international investment in the HEFC funding formulae (paragraph 4.38); but we commend the Funding Councils' moves to give equal weight to applied research (paragraph 4.37).

5.10 The Technology Foresight teams, and the Research Councils, should give due weight to research which may be of interest to users worldwide, even though it may not have a supporter currently located in the UK (paragraph 4.41). If the science base were restricted to working only in areas appropriable within the UK, its scope and standards would drop dramatically.

5.11 The Government must bear in mind the need to preserve the international standing of their research establishments when contemplating changes in the light of the Efficiency Unit scrutiny (paragraph 4.43).

Recommendations to the Universities

5.12 UK universities must maintain a high quality of experience for overseas students if they are to continue to receive a high price, and a quality which will stand international comparison if they are to retain and increase their market share (paragraph 4.21).

5.13 The Committee of Vice-Chancellors and Principals should consider the desirability of drawing up guidance for firms (whether foreign or domestic) and university departments as to how to handle sensitive know-how and information during a contract or collaboration, while preserving academic openness (paragraph 4.27).

5.14 The CVCP, in consultation with the Treasury, should devise a standard formula for costing and pricing research contracted from a university by a government department, and a means of enforcing it (paragraph 4.39). This would strengthen the position of the universities when negotiating with other customers, both foreign and domestic.

INDUSTRIAL SCIENCE

5.15 The Government should keep the regulation of biotechnology and other scientific activities under review as science progresses, and ensure that, if in any respect the UK/EU regime is stricter than that in any major competitor country, this can be fully and explicitly justified (paragraph 4.49).

5.16 The Government are right to treat all companies conducting R&D in the UK as UK enterprises for purposes of access to public R&D support (paragraph 4.52).

5.17 The Scottish, Welsh and Northern Ireland Offices, and the DTI, should consider offering pump-priming funding for developments aimed at attracting international investment in science, awarded by competition among university departments on the basis of a business case (paragraph 4.61).

5.18 The Inland Revenue should be particularly careful, in devising and administering company taxation and in conducting their current Industrial Finance Initiative, that they do not inadvertently create incentives to place R&D outside this country (paragraph 4.62).

APPENDIX 1

Sub-Committee I: International Investment in UK Science

The members of Sub-Committee I were:

L. Butterfield
L. Dean of Beswick
L. Desai
L. McColl of Dulwich
L. Nathan
L. Nelson of Stafford
B. Perry of Southwark
L. Perry of Walton
L. Porter of Luddenham
E. Selborne
L. Tombs
L. Walton of Detchant (Chairman)

The Sub-Committee appointed as their Specialist Advisers, Dr Peter Collins, of the Royal Society, and Dr Paul Whittingham.

APPENDIX 2
List of Witnesses

Those marked * gave oral evidence.

* Association of the British Pharmaceutical Industry
Bayer plc
* Biotechnology and Biological Sciences Research Council (formerly AFRC)
British Aerospace plc
* British Council
British Gas
British Technology Group Ltd
Chemical Industries Association
Ciba-Geigy plc
* Committee of Vice-Chancellors and Principals
* Committee of Scottish Higher Education Principals
Alex Crawford, Editor of *Laboratory News*
Department for Education
Department of the Environment
Department of Health
* Department of Trade and Industry
Department of Transport
Elf Petroleum (UK) plc
Foreign and Commonwealth Office
* Dr Martin Fransman, Institute for Japanese-European Technology Studies
GEC Alsthom Ltd
Glaxo Holdings plc
Higher Education Funding Council for England
Higher Education Funding Council for Wales
Hoechst (UK) Ltd
* IBM (UK) Laboratories Ltd
* Imperial College of Science, Technology and Medicine
Industrial Development Board for Northern Ireland
Inland Revenue
Institute of Biology
Invest in Britain Bureau
Kobe Steel Europe Ltd
Lilly Research Centre Ltd
* Loughborough University of Technology
Manchester Business School R&D Research Unit
Matra Marconi Space
Medical Research Council
Merck Sharp and Dohme
Ministry of Agriculture, Fisheries and Food
* Natural Environment Research Council
Nissan Motors (GB) Ltd
* Northern Telecom, BNR Europe Ltd
Office of Science and Technology
* Olivetti Research Centre Ltd
* Oxford University
Pfizer Ltd
Philips Electronics UK Ltd
Rhône Poulenc Agriculture Ltd
Rhône Poulenc Ltd
Roche Products Ltd
Rolls-Royce plc
* Royal Academy of Engineering
* Royal Society
Science and Engineering Research Council
Science Policy Research Unit, University of Sussex
Scottish Enterprise
Scottish Higher Education Funding Council
Sharp Laboratories of Europe Ltd
Siemens plc

University of Sunderland
Toshiba Cambridge Research Centre Ltd
* UMIST
* Dr Andrew Webster, Anglia Polytechnic University
Welsh Development Agency
Welsh Office

The Committee also acknowledge the assistance of:

Aircraft Research Association
Canadian High Commission
Confederation of British Industry
Department of the US Air Force
Department of the US Army
Economic and Social Research Council
Edinburgh University
EISAI
Enterprise Oil plc
Embassy of France
Embassy of the Federal Republic of Germany
Institute of Energy
Institute of Materials
Institution of Chemical Engineers
Institution of Electrical Engineers
Italian Embassy
Embassy of Japan
Motorola Ltd
Royal Norwegian Embassy
Overseas Development Administration
Royal Society of Chemistry
Schlumberger UK plc
Shell UK Ltd
SmithKline Beecham
Spanish Embassy
UK Science Park Association
University College London
Welding Institute
Wellcome Trust
Yamanouchi Research Institute, Oxford

APPENDIX 3

INTERNATIONAL INVESTMENT IN UK SCIENCE

All figures are real terms, base year 1991/92, using GDP Deflator

OVERVIEW

T1 Overall R&D Expenditure in the UK by Funder

£m	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
Private Non-Profit *	244	242	257	267	291	329	362	401
Higher Education	70	75	86	95	93	90	90	95
Abroad	918	1,111	1,107	1,151	1,306	1,486	1,399	1,328
Government	4,967	4,918	4,796	4,501	4,644	4,504	4,316	4,313
Business	5,412	5,832	6,117	6,549	6,668	6,404	5,994	6,056
	11,611	**12,178**	**12,362**	**12,563**	**13,003**	**12,813**	**12,161**	**12,192**

* Mainly R&D performed by charities

Derived from data from the Annual Review of Government Funded R&D

See also Figure F1 below

T2 All R&D Funds received from Abroad : £m

1991/92	Government	HEIs	Business	Private Non-Profit	Total
Civil	16	107	891	21	1034
Defence	14	0	349	0	363
Totals	30	107	1240	21	1397

1992/93	Government	HEIs	Business	Private Non-Profit	Total
Civil	19	125	867	24	1035
Defence	14	0	279	0	293
Totals	33	125	1146	24	1328

From the Annual Review of Government Funded R&D

R&D INCOMES FROM OVERSEAS

T3 Sources of Funding for UK Business Enterprise R&D (BERD)

£m	From Government	Overseas	Own Resources	Totals
1981/82	2,027	590	4,143	**6,759**
1983/84	2,000	450	4,170	**6,620**
1985/86	1,687	816	4,845	**7,349**
1986/87	1,933	1,010	5,322	**8,265**
1987/88	1,669	1,001	5,676	**8,347**
1988/89	1,446	1,021	6,037	**8,504**
1989/90	1,512	1,179	6,123	**8,813**
1990/91	1,445	1,339	5,852	**8,635**
1991/92	1,135	1,240	5,393	**7,768**
1992/93	1,057	1,146	5,458	**7,661**

Source : Central Statistical Office - CSO (93) 188
See also Figure F2 below

T4 Overseas Incomes of the Research Councils

£m	1991/92	1992/93
SERC	11.8	11.5
NERC	4.4	3.5
ESRC	0.3	0.02
AFRC	1.4	2.1
MRC	6.2	6.8
	24	**24**

Estimated from the Annual Accounts of Research Councils

R&D EXPENDITURE OVERSEAS

T5 Overseas Expenditure of the Research Councils

£m	1991/92	1992/93
SERC	100.4	101.1
NERC	1.7	1.6
ESRC	0.03	0.01
AFRC	0.2	0.3
MRC	4.0	4.4
	106.3	107.4

Estimated from the Annual Accounts of Research Councils

T6 Research Councils : Extra - Mural Spend
Comparing overseas component with others

£m	1990/91	1991/92	1992/93
HEIs + Non Industry Research Institutes	384	372	369
Overseas	108	106	107
Professional & Learned Societies and Persons	2	3	76
Research Councils & Other Government Departments	2	5	9
Industry / Public Corporations & Research Associations	1	1	1

Derived from data from the Annual Review of Government R&D
See also Figure F10 below

T7 Government Civil Departments : Extra - Mural Spend
Comparing overseas component with others

£m	1990/91	1991/92	1992/93
Industry/Public Corporations & Research Associations	462	365	361
HEIs & Non-Industry Research Institutes	188	169	160
Research Councils & Other Government Departments	111	95	115
Overseas	87	90	106
Professional & Learned Societies and Persons	117	83	37

Derived from data from the Annual Review of Government Funded R&D
Excludes MOD
See also Figure F11 below

T8 Government Funded R&D - Overseas Spend

£m	1990/91	1991/92	1992/93
Dpt of Energy	0.85	0.30	**0.00**
Dpt of Transport	0.11	0.00	**0.00**
Economic & Social Research Council	0.11	0.10	**0.00**
Dpt of Environment	0.75	0.30	**0.10**
Dpt of Health	0.11	0.10	**0.19**
HSC/E	0.11	0.20	**0.19**
Agricultural & Food Research Council	0.00	0.20	**0.29**
Dpt of Education	0.21	0.30	**0.39**
Office of Public Service & Science	0.00	0.00	**0.39**
Natural Environment Research Council	2.24	1.90	**1.74**
Medical Research Council	4.26	4.20	**4.44**
Overseas Development Agency	12.26	12.70	**30.53**
Dpt of Trade & Industry	72.81	75.50	**74.30**
Science & Engineering Research Council	101.60	99.90	**100.68**
Ministry of Defence	155.54	167.60	**164.73**
	351.0	**363.4**	**378.0**

Other Departments are zero
Derived from data from the Annual Review of Government Funded R&D
See also Figure F12 below

T9 Government Funded R&D - Overseas Spend - Civil / Defence Split

£m	Civil	Defence	Total
1984/85	195.92	130.86	**326.8**
1985/86	208.18	154.66	**362.8**
1986/87	206.39	116.94	**323.3**
1987/88	213.70	79.18	**292.9**
1988/89	214.99	76.04	**291.0**
1989/90	200.23	167.97	**368.2**
1990/91	195.52	155.54	**351.1**
1991/92	195.90	167.60	**363.5**
1992/93	213.43	164.73	**378.2**

From the Annual Review of Government Funded R&D
See also Figure F13 below

T10 The "Notional" UK contribution to EU R&D

This contribution to EU R&D is towards the cost of the total programme and not any particular elements. It is assumed to be in the same proportion as the UK's contribution to the EU budget as a whole. It is thought that EU spending on R&D in the UK is of the same order as this.

	1983/84	1984/85	1985/86	1986/87	1987/88	1988/89	1989/90	1990/91	1991/92	1992/93
£m	87.4	93.7	115.9	132.4	144.5	159.5	198.2	221.1	189.2	242.3

OVERSEAS STUDENT FEES

Science Subjects only
Former polytechnics excluded

T11 Total Fee

£m	1990/91	1991/92	1992/93	1993/94
Post-Graduate (Full - Time)	81	84	87	92
Post-Graduate (Part - Time)	7	7	8	9
Under-Graduate (Full - Time)	73	84	93	103
	161	**175**	**188**	**204**

T12 Paid for by UK Sources (Expenditure)

£m	1990/91	1991/92	1992/93	1993/94
Post-Graduate (Full - Time)	35	36	34	35
Post-Graduate (Part - Time)	3	3	4	4
Under-Graduate (Full - Time)	16	22	25	28
	54	**61**	**63**	**67**

T13 Paid for by Overseas Sources (Income)

£m	1990/91	1991/92	1992/93	1993/94
Post-Graduate (Full - Time)	46	48	53	57
Post-Graduate (Part - Time)	4	4	4	5
Under-Graduate (Full - Time)	56	62	68	75
	106	**114**	**125**	**137**

Note : For the year 1991/2 a further £39 millions of fee income is thought to result from overseas students in the former polytechnics.

OVERSEAS STUDENT NUMBERS

Science Subjects only
Former polytechnics excluded
All students, not just new registrations

T14 Full-time Post-Graduates

	Dec 1990	Dec 1991	Dec 1992	Dec 1993
Private Funds	3,422	3,470	3,631	4,146
Overseas Government	2,228	2,191	2,632	2,866
Other Overseas Scholarships	395	355	347	359
Overseas Universities	358	394	383	404
International Agencies	279	274	155	137
Commonwealth Scholarship	275	363	381	334
Overseas Industry & Commerce	273	283	303	338
EU Funding	0	228	243	290
Paid from UK Sources	**5,349**	**5,537**	**5,225**	**5,423**

TOTAL	**12,579**	**13,095**	**13,300**	**14,297**

T15 Part-time Post-Graduates

	Dec 1990	Dec 1991	Dec 1992	Dec 1993
Private Funds	973	986	1,165	1,331
Overseas Government	167	109	112	122
Other Overseas Scholarships	46	52	42	39
Overseas Industry & Commerce	40	49	60	67
International Agencies	38	29	19	21
Overseas Universities	26	26	42	46
Commonwealth Scholarship	23	16	15	20
EU Funding	0	33	43	41
Paid from UK Sources	**916**	**1,202**	**1,275**	**1,329**

TOTAL	**2,229**	**2,502**	**2,773**	**3,016**

T16 Full-time Undergraduates

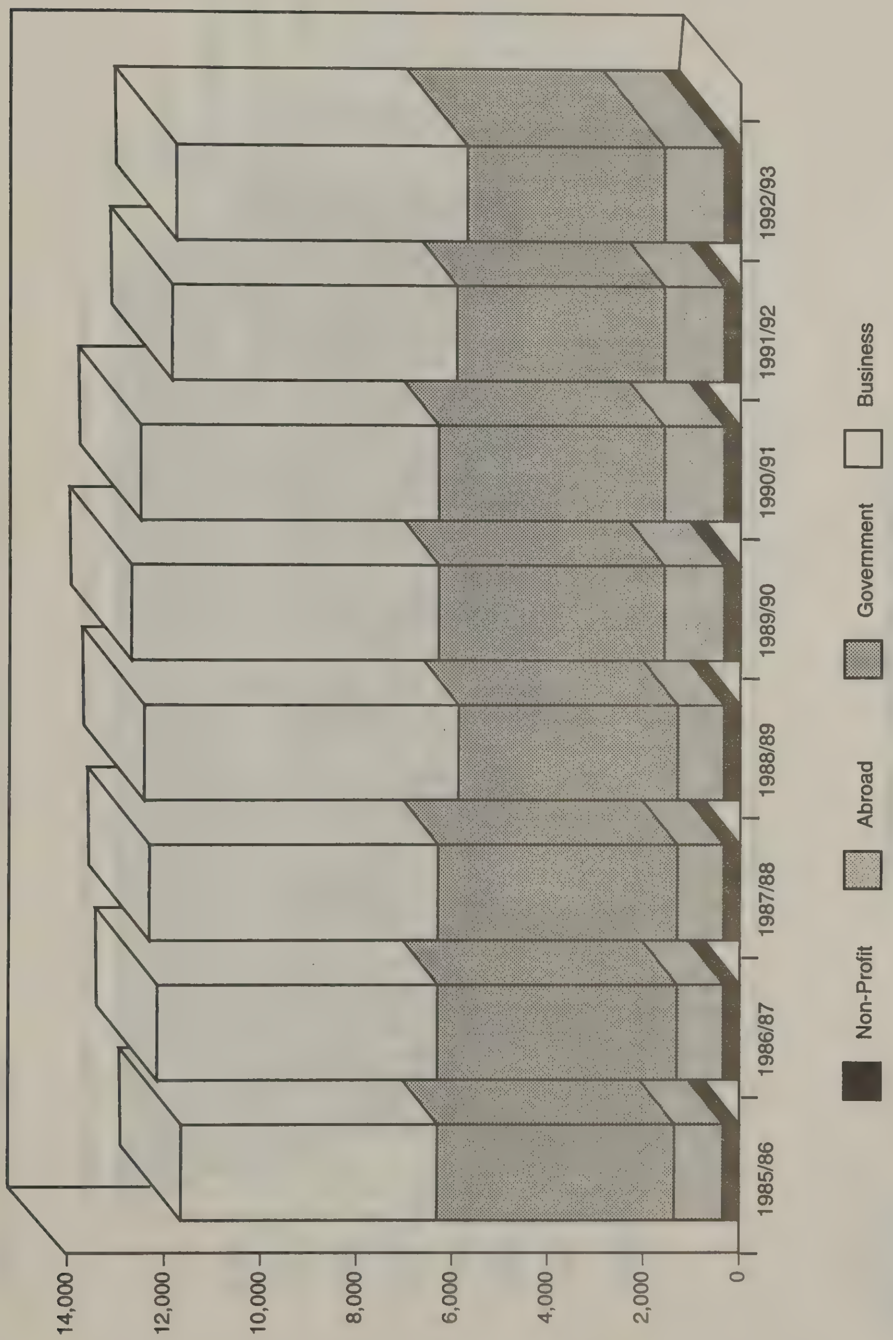
	Dec 1990	Dec 1991	Dec 1992	Dec 1993
Private Funds	6,551	6,550	6,598	7,018
Overseas Government	1,523	1,349	1,582	1,760
Overseas Universities	103	86	106	136
Overseas Industry & Commerce	69	142	186	260
International Agencies	41	118	8	6
EU Funding	0	782	1,272	1,544
Commonwealth Scholarship	0	7	16	29
Other Overseas Scholarships	0	121	125	153
Paid from UK Sources	**4,608**	**5,019**	**5,898**	**6,853**

TOTAL	**12,895**	**14,174**	**15,791**	**17,759**

Part-time Undergraduates from Overseas - Negligible Numbers
All student numbers and fees are derived from data from Universities' Statistical Records

F1

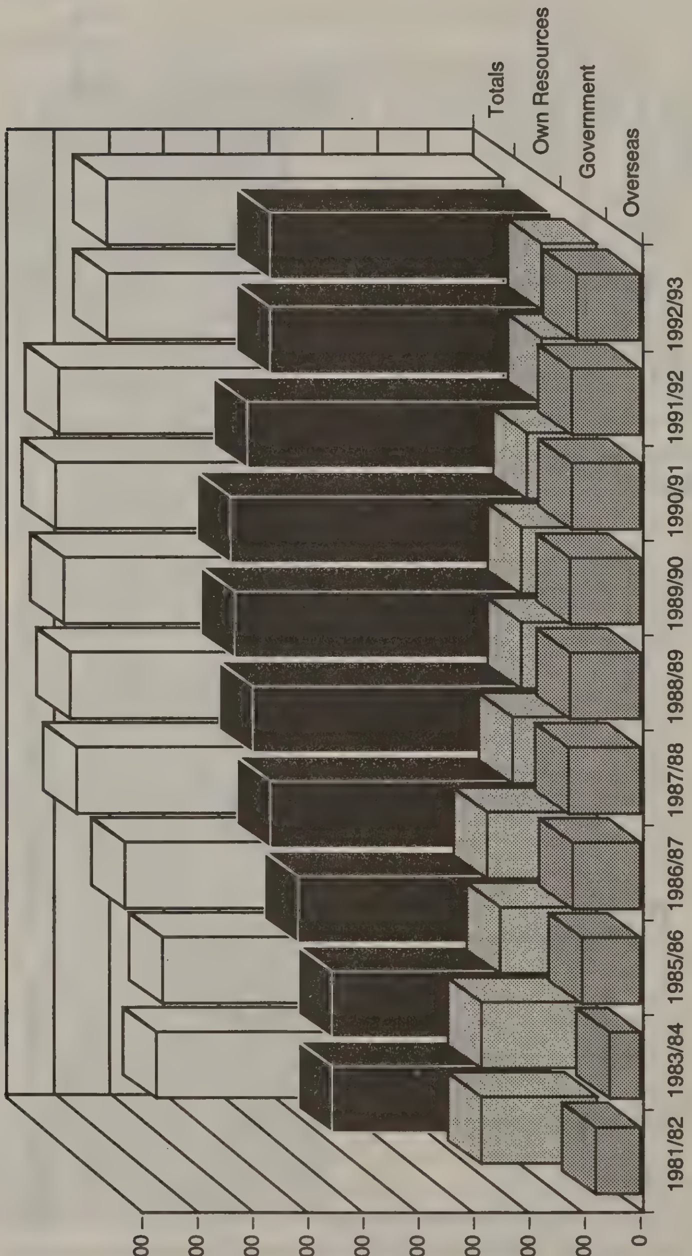
Overall R&D Expenditure in the UK by Funder - £m



Source: Table T1 above

F2

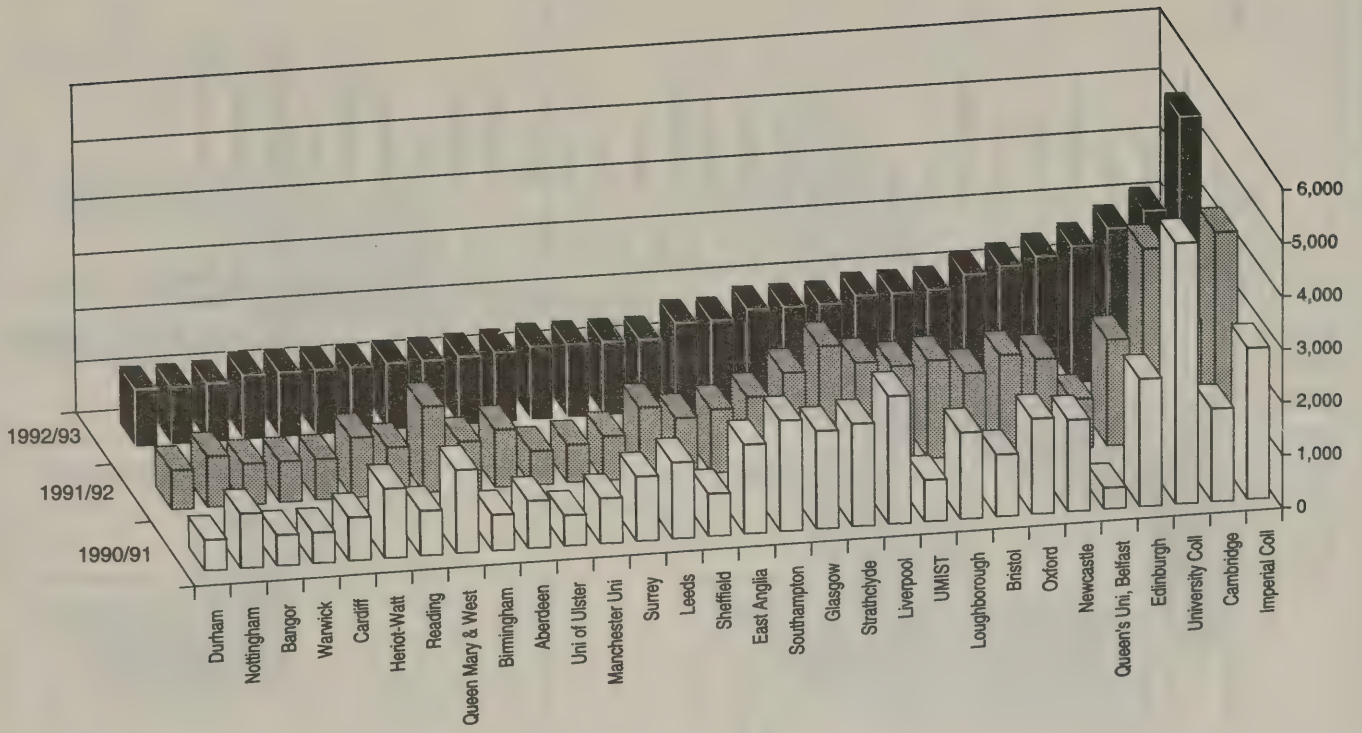
Sources of funding for UK BERD - £m



Source: Table T3 above

F3

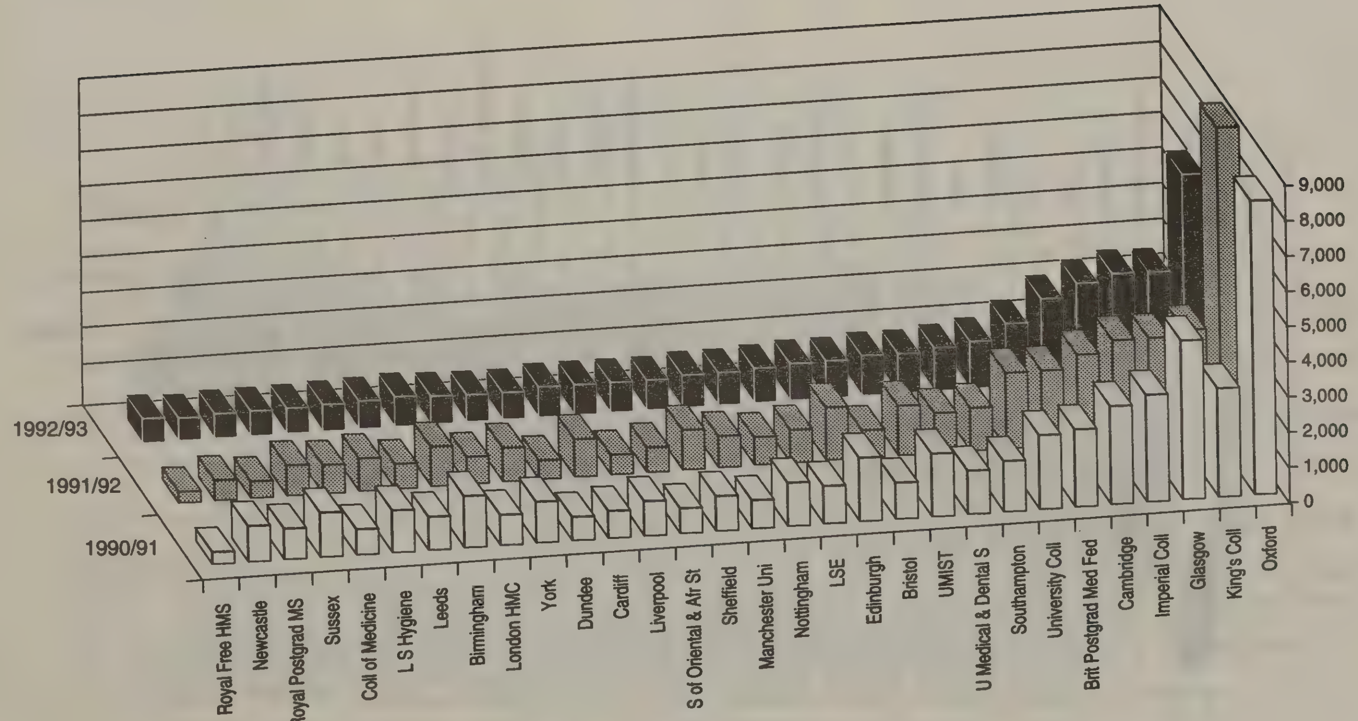
University Research Grant & Contract Income from European Union Sources



Top 30 for 1992/93
£ thousands
Former polytechnics excluded
All disciplines
Derived from data from Universities' Statistical Records

F4

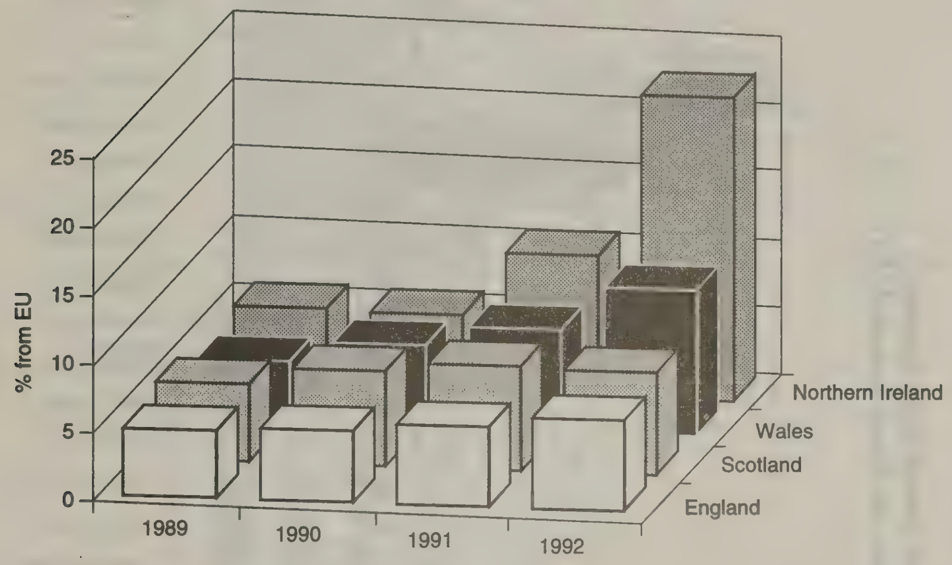
University Research Grant & Contract Income from Overseas Industry Sources



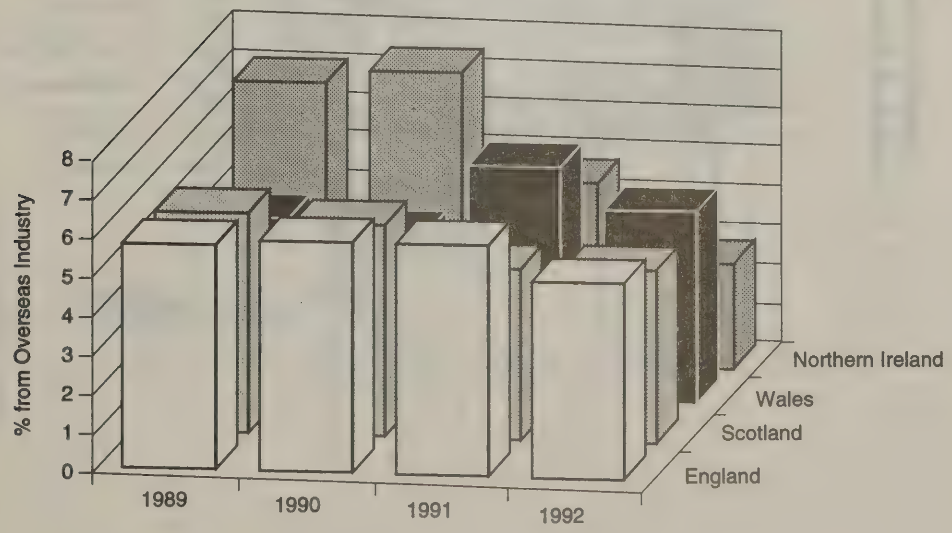
Top 30 for 1992/93
£ thousands
Former polytechnics excluded
All disciplines
Derived from data from Universities' Statistical Records

Regional dependency: Income from European Union (F5) and Overseas Industry (F6) as a % of the total University Research Grant & Contract Income.

F5 Regional Dependency on EU Research Income



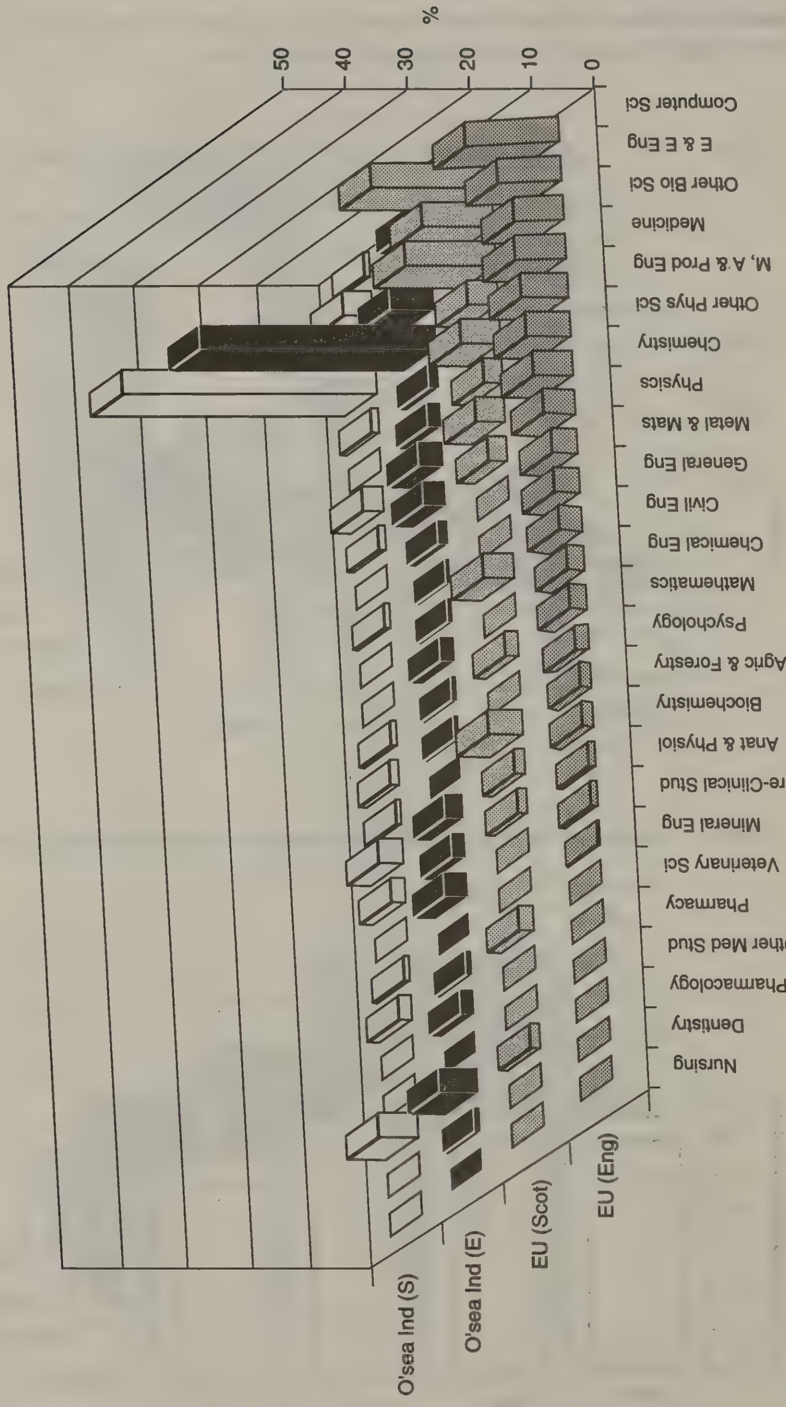
F6 Regional Dependency on Overseas Industry Research Income



Derived from data from Universities' Statistical Records

F7

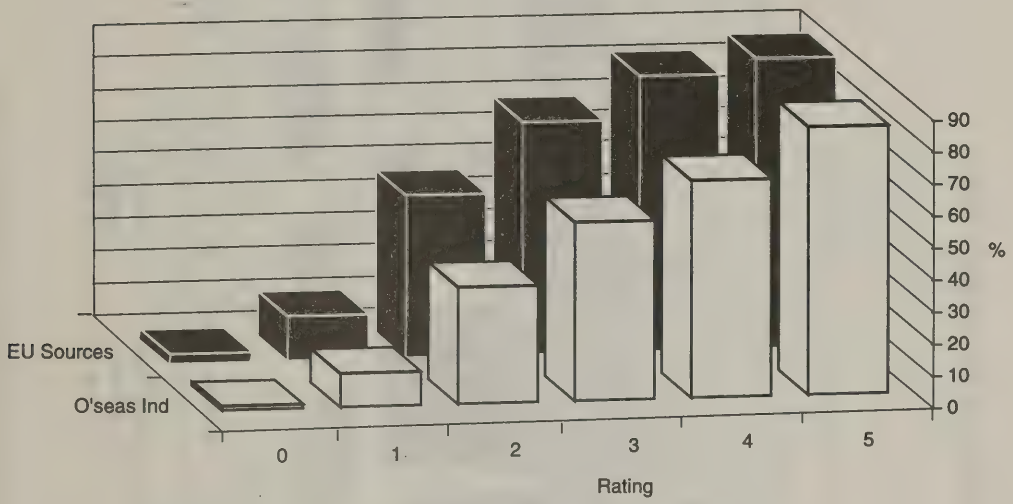
Research Grant & Contract Income from Overseas Scottish & English Universities - By Disciplines - 1992/93



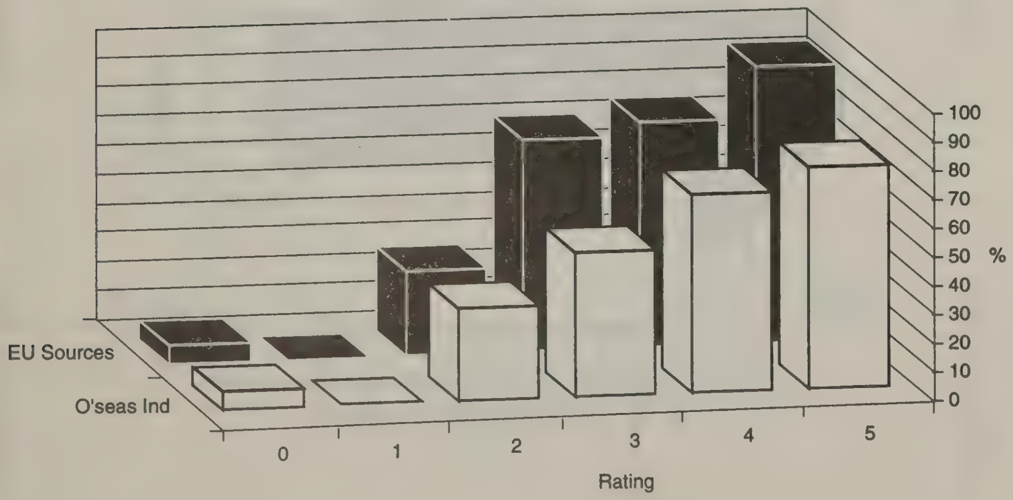
As % of category total
Science disciplines only

Research assessment ratings and overseas income - % of departments rated 5–1 or unrated (0) which received overseas income in 1992/93 - Former polytechnics excluded

F8 % of Rated Departments Receiving Funds - England

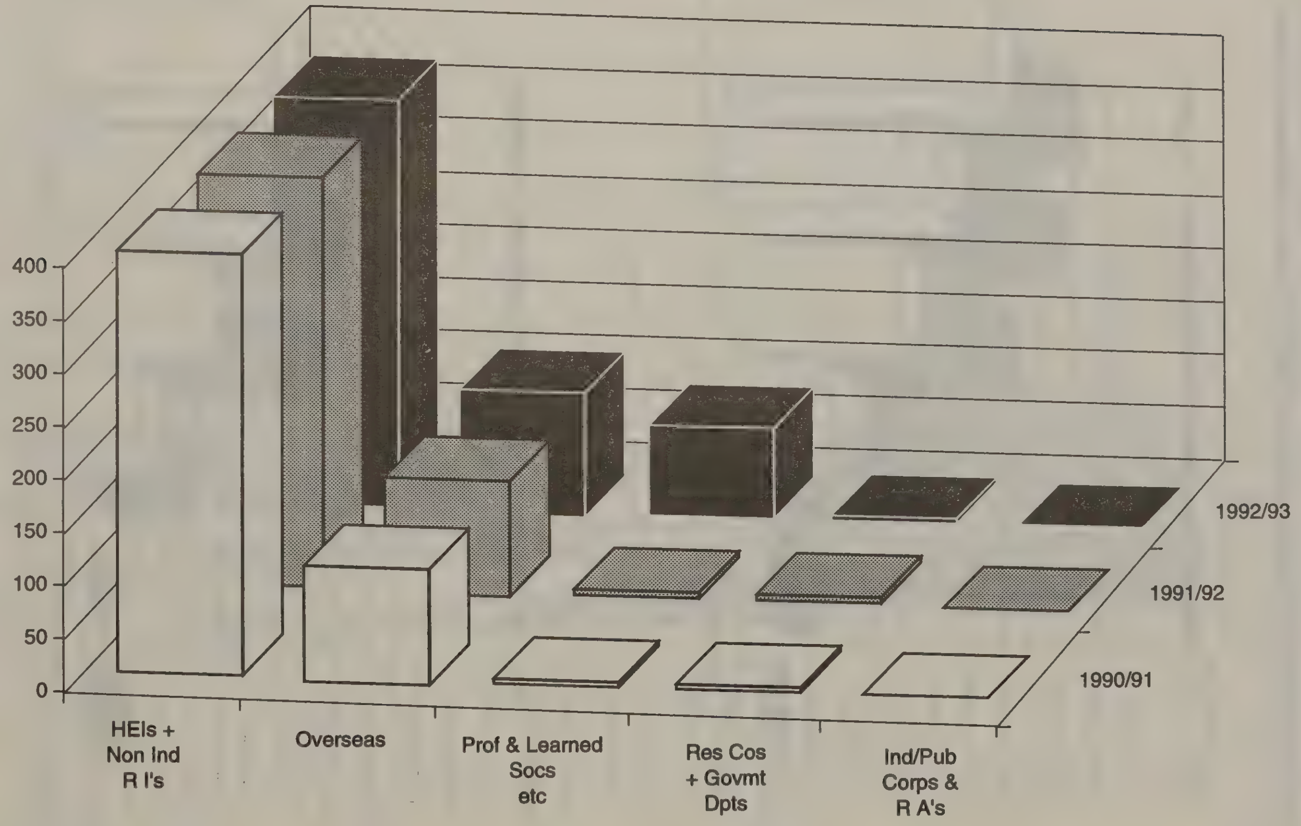


F9 % of Rated Departments Receiving Funds - Scotland



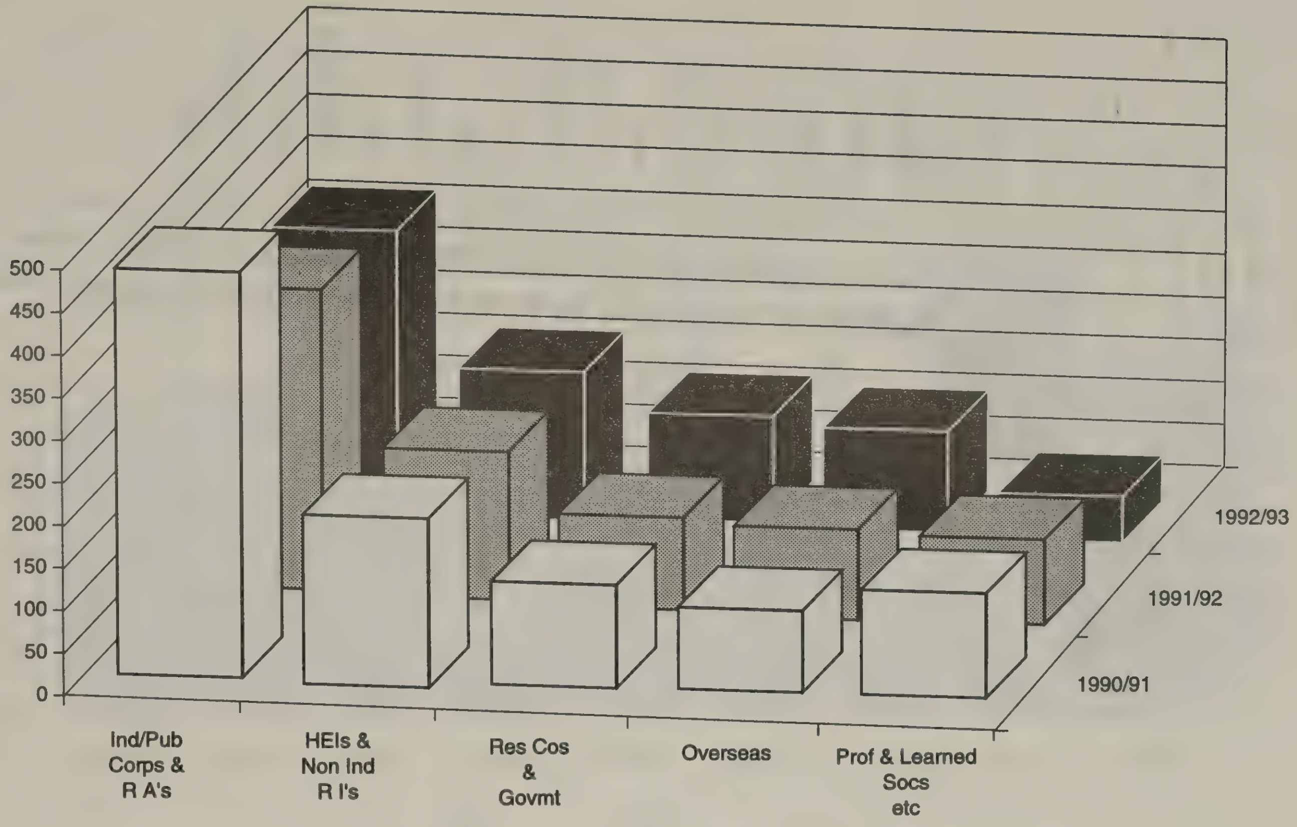
F10

Research Councils: Extra-Mural Spend – £m



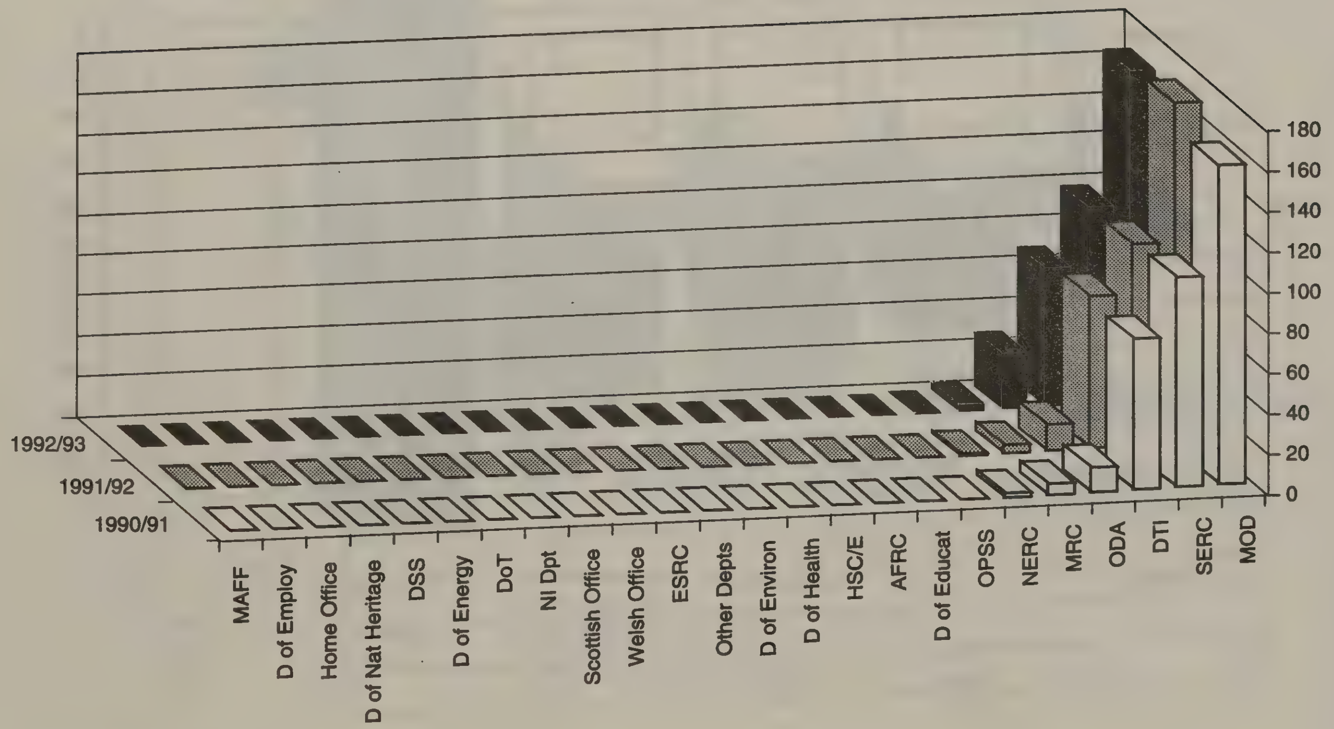
Source: Table T6 above

F11 **Government Civil Departments: Extra-Mural Spend – £m**



Source: Table T7 above

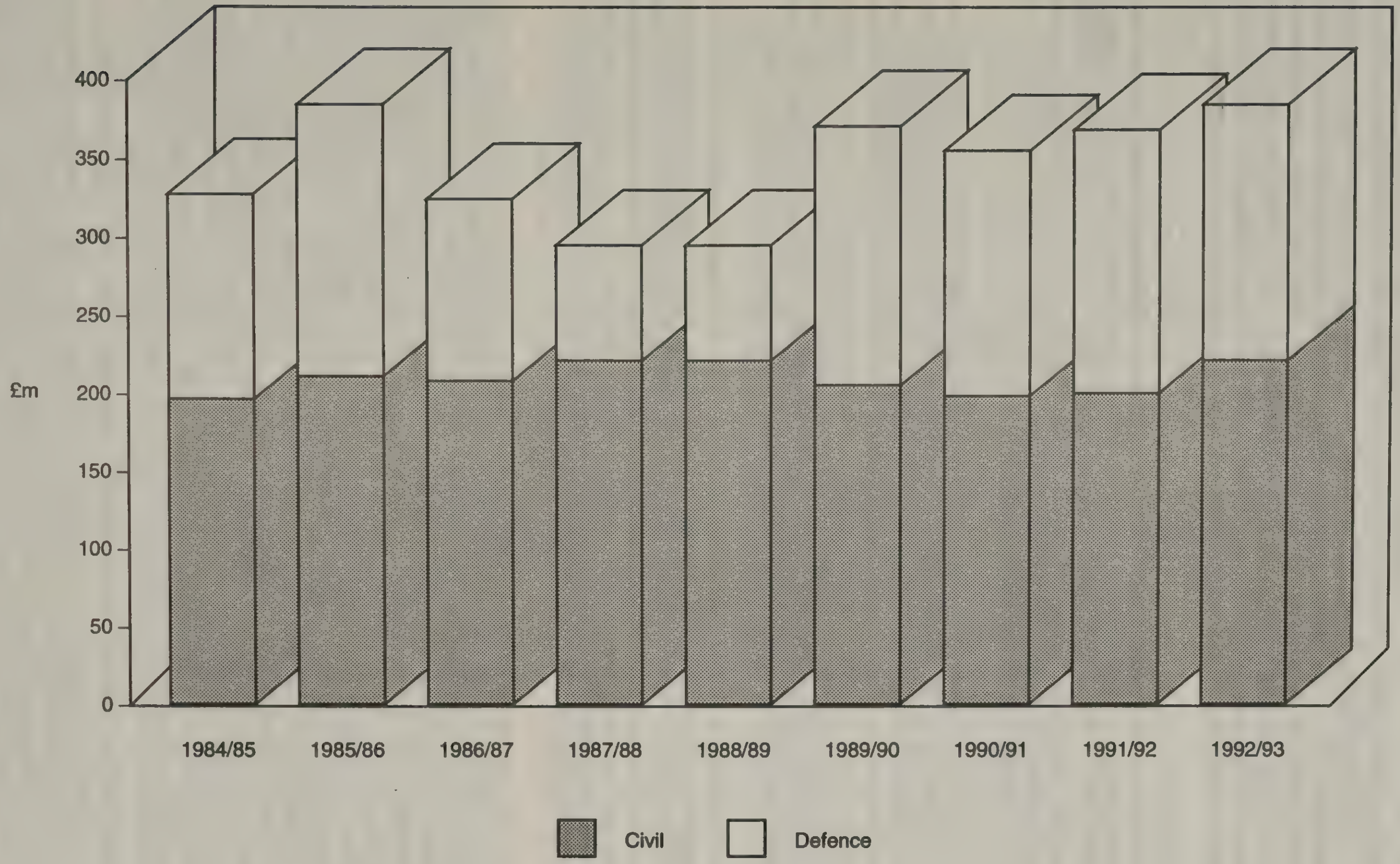
F12 Government Funded R&D – Overseas Spend – £m



Source: Table T8 above

F13

Government Funded R&D – Overseas Spend – Civil/Defence Split



Source: Table T9 above

APPENDIX 4

Japan

Globalisation of Japanese R&D

Japan has been outward-looking since the Meiji restoration of 1868; but the phenomenon of "globalisation" of R&D by the big corporations is very recent: the Japanese White Paper on Science and Technology of 1991 (see Annex) indicates that it has arisen since about 1985. Typically, the big corporations are aiming to have research facilities in each of the three main markets: North America, Western Europe and South-East Asia. In 1992 the Government of Japan adopted a Basic Policy for Science and Technology which includes "Intensification of international activities" (see Annex). Within Europe, the preferred location seems to be the United Kingdom, followed by Germany and France.

For this reason, current interest in foreign investment in UK science is focused on Japan - to an extent out of proportion to the scale of investment so far involved. We have received evidence from Dr Martin Fransman, Director of the Edinburgh University Institute for Japanese-European Technology Studies, as well as from two former British Science Counsellors in Tokyo: Dr Clive Bradley, now Managing Director of Sharp Laboratories of Europe Ltd, and Dr Richard Hinder, now head of the International Branch of the Management and Technology Services Division of the DTI. We are also grateful to the Embassy of Japan for supplying the documents summarised in the Annex.

Dr Fransman identifies 73 Japanese R&D organisations in the UK (Q501), of which 19 are "stand-alone facilities" (ie not colocated with manufacturing - Q508). This represents 36% of all the Japanese R&D organisations in Europe; Germany has 19%. It is his impression that these proportions would be similar if the amount of investment were expressed in money terms (Q511). Of these 73 organisations, only about 10 are doing pure research, as opposed to development (Q515). Of these 10, seven surveyed by Dr Fransman's Institute in 1991 employed 105 researchers (78 British, 27 Japanese); six of them then expected to be employing 180 researchers by 1995 (141 British, 39 Japanese). As Dr Fransman observed, "The total number of researchers that we are talking about at this point is relatively limited".

The DTI Invest in Britain Bureau has produced a list of Japanese companies involved in research, development or design in the UK. The list includes 98 companies, of which 16 have no associated UK manufacturing base, 13 are devoted to basic research, and 13 more are said to include basic research along with other activities. 28 are involved in electronics (including semiconductors and consumer electronics), 15 in the motor industry, and seven in chemicals/pharmaceuticals. The discrepancies between the IBB's figures and Dr Fransman's (which derive partly from a survey by the Japan External Trade Organisation, JETRO, in 1992) are due to differences in definition.

Six of the organisations on the IBB list have addresses within UK universities: the Aisin Seiki Research Laboratory at the University of Sussex (vehicle parts), the Eisai London Research Laboratory at University College London (pharmaceuticals and neuroscience), the Fujisawa Institute of Neuropharmacology at the University of Edinburgh, the Hitachi R&D Centre at the Cavendish Laboratory in Cambridge, the Satake Centre of Grain Processing Technology at UMIST, and the Tanabe Neuropharmacology Research Group at the University of Strathclyde. The list also reveals the Teijin Biomedical Laboratory at the MRC Collaborative Centre at Mill Hill. Dr Fransman identified for us several more major Japanese research centres which, while not part of a university, are colocated with one: the Canon Research Centre and the Kobe Steel Research Laboratory on the University of Surrey Research Park in Guildford, the Nissan European Technology Centre on the Cranfield Technology Park, the Toshiba Research Centre on the Cambridge Science Park, Sharp Laboratories of Europe on the Oxford Science Park and the Yamanouchi Research Institute on the Oxford Littlemore Hospital Site. This gives a total of 13 Japanese research organisations which are part of, or physically connected to, the UK science base. All but two of them are in the key sectors of electronics, pharmaceuticals and vehicles.

Of these, we have received written evidence from Kobe Steel, Nissan and Toshiba, plus Sharp and Yamanouchi whose establishments in Oxford received members of Sub-Committee I most hospitably in March. Kobe's European Research Laboratory was established in 1988; it employs about 30 people; it is researching polymers and composites, for applications in high-performance reinforced plastics, and diamond thin films for electronic applications. Nissan's European Technology Centre, established in 1988, is engaged in design and development for the European market. Toshiba's Cambridge Research Centre was established in 1991; it employs 13 staff, and the Managing Director is concurrently Professor of Physics at the Cavendish Laboratory; research is conducted into the physics of advanced semiconductor structures, much of it in collaboration with the University; this is Toshiba's first and only corporate research laboratory outside Japan. Sharp Laboratories of Europe was founded in 1990; it employs 45 staff on research including multilingual translation software and autostereoscopic 3D moving pictures. The Yamanouchi Research Institute was also opened in 1990; it employs 22 scientists in strategic cell biology research.

According to Imperial College (p3), the number of new approaches from Japanese firms seeking collaboration has declined markedly since Japan went into recession.

Oxford University has a reputation for particularly close links with Japan, and the Vice-Chancellor, Dr Peter North, was kind enough to give us some details (p2, Q3). The connexion goes back to the last century; members of the Japanese Imperial Family have studied in Oxford since the 1920s, as have the present Crown Prince and his wife. Oxford currently enjoys a range of donations, benefactions and sponsorships from Japan, including in particular the Nissan Institute of Japanese Studies, opened in 1981. However, "It is perhaps surprising that there have been relatively few research contracts or other forms of research collaborations with Japanese companies".

Why do Japanese companies locate R&D in the UK?

The Japanese companies who gave evidence to us gave the following reasons for being here:

- Kobe Steel established a laboratory in Europe to pave the way for more active business development; to access European science and technology; to bring a multicultural approach to its research; and to hedge against a shortage of researchers in Japan. They chose the UK because of the high reputation of relevant UK science - although Germany had a better technology base; the English language; the welcome extended by institutions and individuals, which was warmer than in France or Germany; and relationships already built up with certain universities and senior scientists.

- Sharp cited the following benefits of doing R&D in Europe: a complementary research culture; integration into the European market, and avoidance of trade friction; access to European science; lower costs than in Japan; and general "image building". They came to the UK because of the language, and the UK's reputation in basic research and research training.

- Toshiba was attracted to the UK by the strength of basic research, and the freedom of institutions to develop contacts and collaboration.

- Yamanouchi came to Europe to diversify their research style, to make contacts, and of course to get results. They chose the UK for the excellence of relevant science, the language, and the culture - "We laugh at the same jokes".

These four examples, from three different sectors, all display an interest in basic science. Yet the findings of two Japanese surveys, the Science and Technology Agency survey of 1991, summarised in the Annex, and the *9th Survey of European Operations of Japanese Companies in the Manufacturing Sector* of October 1993 by the Japan External Trade Organisation (JETRO), indicate that these examples are not typical: most Japanese investors in UK science are mainly interested in product development for the European market. Of the companies with European research facilities surveyed by the STA, 70% established them "to develop products that meet local needs", 45% "to search for the seeds of new technology", 35% "to employ and utilise excellent R&D staff", 30% "to upgrade existing production facilities", 25% for the sake of collaboration, 15% as part of a merger or takeover, and 5% "to stimulate the activity of the whole company". Of 170 companies with research in the UK, France or Germany surveyed by JETRO, 85% were looking for products to meet local needs; 61% for up-to-date knowledge of "local technological trends" in order not to be caught out by local competition; 42% for shorter lead times between research and production; 36% for an expanded research culture; 18% for inside information on European research; 17% for joint research projects; and 11% for additional researchers; only 3% were seeking to satisfy demands by the local government for local research content.

Dr Fransman confirmed for us that Japanese R&D in the UK may be divided into two types: research tied to production plants, and research linked with university activities (Q501). By the same token, he identifies two reasons why the UK is the preferred location for Japanese R&D in Europe. One is that the UK is also the preferred European location for investment in manufacturing. The other is the strength of British university research, and "the open attitude that UK researchers have to interacting with Japanese researchers" - particularly by comparison with Japanese academics. This comparison is significant: what enables UK scientists to work well with Japanese industrial researchers is not only that they are from Japan, but that they are from industry, and by world standards UK academic-industry relations are now very good (p7, QQ87, 363).

Dr Fransman offered us underlying explanations for these reasons. By his analysis, Japanese manufacturing investment has been welcomed to the UK because it "has tended to complement rather than compete with our own industry" (Q502; cp QQ80, 148), for example in consumer electronics and semiconductors (Q525), whereas the USA, France, Italy and Germany have seen Japanese investment as more of a threat; other factors are the language, and low labour costs by the standards of the European Union. British academics are open to interaction with Japanese companies partly, of course, because they need money, but also because "increasingly, Japanese companies themselves are doing very interesting advanced research".

Dr Geoffrey Robinson has investigated the growth of Japanese investment in UK science for the DTI, and his findings match those of Dr Fransman fairly well (QQ77-9, 90, 93). He too distinguishes major investments in development, tied to manufacturing and focused on the needs of a local market, from small-scale investments in research. He finds that the first reason for investment is product development.

> "The second reason that they give, and it is a fairly typical Japanese reason, is that they believe that the West has creative abilities that the Japanese do not have and increasingly, as valued-added products need an element of creativity, innovation, flair or design, then they wish to get access to that skill which they feel they do not have in Japan. Sometimes that is in universities and sometimes it is in the commercial design community".

Dr Robinson also cites the trend towards local sourcing of components ("You cannot work with suppliers if you have not got your technology base, at least part of it, in the country concerned"); the level of welcome, at both government and social level; and the language. He parts company from Dr Fransman in claiming that the quality of British science is not a decisive factor: "they feel that, wherever they come in Europe, they are going to tap into the best science wherever it is".

The DTI's supplementary evidence (p200) cites a further important reason, which echoes the evidence of Kobe Steel: "personal links established over the years", particularly through Japanese researchers who have come to the UK under the auspices of the British Council. The Council themselves claim, as successes of this type, the Eisai, Hitachi and Sharp Laboratories, and the Honda wind tunnel at Imperial College (p75). In their supplementary evidence (p87) they give their own list of reasons for Japanese investment in UK science: besides personal contacts, they cite the reputation of British science for excellence and creativity; the similarity of the British approach to research and higher education to the approach in the USA, with which many Japanese are also familiar; the welcoming attitude of universities and government; language; "trust and understanding"; low costs; and "free and open markets (financial system)". But they conclude by supporting Dr Fransman against Dr Robinson: "The most important factor is that we [in the UK] have the researchers with the record that they seek and need".

Reciprocity

It has been suggested that Japan is more willing to place her research and researchers abroad than to allow researchers from overseas to operate in Japan. Our evidence firmly refutes this. According to the DTI (p200):

> "There are increasing links between foreign companies and Japanese scientists. For example, ICI received a warm reception when setting up their research laboratories at Tsukuba, as did Glaxo. Both companies received considerable help from the Japanese".

The British Council confirms this, adding the example of Unilever (Q342). According to Dr Fransman (Q522), there is an imbalance between Japanese researchers working in the West and western researchers working in Japan; but it is due to reluctance on the part of westerners to move to Japan, rather than any resistance from Japan, and it embarrasses the Japanese. He mentioned Japanese schemes to support visiting scientists, run both by government agencies (MITI and the Science and Technology Agency) and by companies (eg Hitachi). The Japanese Basic Policy for Science and Technology includes "promoting the employment/acceptance of foreign researchers and smoothing their activities in Japan, while implementing training in the Japanese language and expanding fellowships".

Government initiatives to encourage scientific relations with Japan

Biennial bilateral Round Table Talks on Science and Technology between the UK and Japan have been held since 1989 (Q340), involving on the British side of the table the Government Chief Scientific Adviser, the main R&D spending departments, the research councils, the British Council, the Royal Society and other bodies. Dr John Richards of the British Council told us,

> "...the benefit of that process is that it does provide a loose framework for encouraging collaboration. It does provide an opportunity to exchange areas and to identify problems that might interfere with the relationship between the two countries, but it is not particularly prescriptive; it is an encouraging process and it allows the research councils and other bodies then to go away, having identified key individuals in both countries to carry forward a particular area of collaboration and it is then a question of exploring whether those are feasible and reporting back at some later stage. It is therefore actually quite a useful way, I think, in which Government can encourage collaborative research..."

Imperial College (p1) gave us an example of investment flowing from this process: £600,000 p.a. from the Japan Research and Development Corporation for a joint project with the EPSRC (former SERC) in microelectronics.

In the same year, the British Council established the Collaborative Research Project scheme:

> "British Council funds are deployed flexibly with a view to attracting Japanese co-funding in the form of equipment, access to facilities, research cost contribution and matching exchange funds. Currently there are some 48 programmes of on-going collaborative research. The CRPs have been used to support activity agreed through the official UK/Japan S&T Round Table Talks which take place every two years. There is a regular dialogue between the British Council staff in Tokyo and the UK Research Councils which helps to determine priorities for bilateral collaboration" (p77).

In 1993, the Council and the Japan Society for the Promotion of Science established a Joint Research Programme.

The Council has given us examples of major Japanese investments in UK science arising out of collaborations under these schemes: provision of an advanced spectrometer worth £1.2m for the ISIS neutron spallation source at the Rutherford Appleton Laboratory, £7m for a joint muon production facility also at RAL, and £1m worth of equipment for Imperial College and Cambridge as part of a joint research project into atom arrangement, design and control for new materials (p75).

In 1991, the DTI launched the Engineers to Japan scheme (Q63), administered by the Royal Academy of Engineering. The scheme enables qualified industrial engineers to work in a Japanese company for 6-12 months, on a project agreed by the two companies. The DTI funds half the cost of each secondment. The scheme is supported by the Japanese Ministry of International Trade and Industry (MITI). For academic scientists, in April this year the Royal Society launched the Travel to Japan scheme, within the framework of their University Research Fellowships, to encourage researchers to spend up to a year working in Japan. Dr Martin Fransman commented (QQ520-521) that these schemes do the vital job of facilitating the initial contact which may in time lead to a major collaboration or investment; but that they are on a small scale, particularly by comparison with similar schemes in France, and ought to be expanded.

There has been further recent high-level activity. In August 1993, the OST set up the UK/Japan and Asia-Pacific Advisory Group on Science and Technology, to advise the Government on ways to foster beneficial S&T relations. The Chairman is Sir Geoffrey Allen, chairman of the SERC 1977-81, Head of Research for Unilever 1981-90 and now Executive Adviser to Kobe Steel. Members include the Government Chief Scientific Adviser, Professor Sir William Stewart, and representatives of industrial and academic science with experience of research or business links with Japan. The Group's first report, on scientific relations with Japan, was published in October. In September Mr William Waldegrave visited Japan as Minister for Science; this was followed up when Lord Strathclyde visited Japan as DTI Minister for Small Firms in March 1994, and when a group of potential investors from Japan were invited to the UK in the DTI's first ever "inward mission" focused on R&D (Q687).

Most recently, on 13 June 1994 a formal Agreement for collaboration in science and technology for peaceful purposes was signed in Tokyo by Mr William Waldegrave and the Foreign Minister of Japan. The Agreement provides for the development of co-operative activities, by means which may include expert meetings, exchanges of information and programmes of scientific visits and exchanges; it will be overseen by a Joint Committee.

ANNEX

Globalisation of Japanese R&D

Summary of findings of a survey of private enterprises' R&D by the Japanese Science and Technology Agency in June 1991, as set out in Japan's White Paper on Science and Technology 1991

"When globalising their business activities, Japanese companies first began by establishing bases for sales activities, followed by those for production. In recent years, they have been setting up overseas facilities dedicated to R&D".

The survey repeated an exercise conducted in 1986. It covered 850 companies, with 276 overseas R&D facilities owned by 14% of the companies, mostly larger companies. Companies with no such facility gave as reasons either lack of need or lack of resources. Most such facilities were in the USA, followed by Western Europe. Most had been set up since 1985. In 1991, most facilities at the planning stage were to be in Western Europe, "taking into account the forming of the single market". The average number of staff in such facilities had risen, from 1-4 in 1986 to 20-49 in 1991, and was expected to go on rising. Local staff outnumbered Japanese staff. The White Paper acknowledged "the misunderstanding that Japanese companies are monopolising talented people overseas for their own sake", and suggested correcting it by means including publishing results of research.

The survey found four reasons for maintaining overseas R&D facilities: to upgrade production; to improve products, and develop products for the local market; "to search for the seeds of new technology (basic research)"; and to employ excellent staff, of whom there was evidently a shortage in Japan relative to demand. The second reason (products) was the dominant one; otherwise, the first two (production and products) were more important in the Far East, and the last two (basic research and staff) in the USA and Europe.

As to what these facilities were engaged in, most were mainly developing products for the local market; improving productivity, seeking compliance with local regulations, basic research and "development of core technology" were all minority activities, though the last was expected to be more important five years on.

The survey identified various difficulties experienced in managing overseas facilities: communication, either with HQ in Japan or with local production; recruitment and regulation, particularly in the Far East; and handling intellectual property.

83% of the companies with overseas facilities had joint research activities with local universities, companies or government organisations, at an average of two current collaborative projects per company; the average in 1986 was only one. 24% of the companies had given grants or contracts to foreign universities, and the scale of such activity was expected to increase.

While only 14% of the companies surveyed possessed overseas R&D facilities, 35% were involved in international collaboration, on a much larger scale than in 1986. Three main reasons were given: "searching for original ideas and unique technology", product development, and moving towards globalisation. 60% intended to develop their international R&D activities; only 34% did not.

The White Paper concluded,

> "Lately, companies have been active in establishing research facilities overseas. Their next step is to obtain successful results from these R&D facilities. They will need to ensure consistency with the headquarters' strategies, as well as with other overseas R&D facilities. Also, as highly qualified researchers are employed at overseas R&D facilities, companies will need to develop effective management methods for the personnel. The companies also must ensure that the results obtained through research activities will contribute to the benefit of the local community".

Extracts from the Government of Japan's Basic Policy for Science and Technology, 24 April 1992 (official translation)

"Intensification of International Science and Technology Activities

In order to intensify international activities, considering Japan's position in international society, the government will:

(a) promote international collaborative R&D;
propose and lead international collaborative R&D adopting original idea of Japan;
improve the environment required for promoting the international collaborative R&D;..."

"(e) establish an internationally opened research scheme by promoting the employment/acceptance of foreign researchers and by smoothing their activities in Japan, while implementing training on the Japanese language and expanding fellowship, and so on;
expand the chances of dispatch of Japanese researchers and administrators to foreign countries;..."

APPENDIX 5
Pharmaceuticals

The pharmaceutical sector

The pharmaceutical industry is one of the three key sectors for international investment in UK science, and significantly different from the other two, electronics and motor vehicles: the indigenous UK industry is strong; and the main sources of international investment are the USA and Europe, rather than Japan. The sector is so dominated by global companies that labelling by "country of origin" is arguably misleading: "The biotechnology and pharmaceutical industries ... are highly international in their perspective and operations; [geographical proximity] will therefore have relatively little influence" (MRC p204). The position of research in the industrial process is also different. Pharmaceutical companies depend on new drugs for profitability (p5); a relatively high proportion of the effort required to launch a new pharmaceutical product goes into basic science, discovering new molecules and new drug targets, followed by a lengthy process of testing and clinical trials, and by comparison relatively little into product development. It is therefore a sector in which relations between industrial and academic scientists tend to be close. Finally, it is a sector whose market is dominated by government purchasing.

From the pharmaceutical sector, we have had evidence from ten major international drug companies investing in UK science: Glaxo, SmithKline Beecham, Pfizer and Eli Lilly, brought before us by the Association of the British Pharmaceutical Industry (ABPI), and also Bayer, Ciba-Geigy, Hoechst, Merck Sharp and Dohme, Roche and Yamanouchi. We have also had evidence from Dr Andrew Webster, Director of the Science and Technology Studies Unit at Anglia Polytechnic University, who has studied academic-industry relations in this sector, and from the Department of Health; and in March members of Sub-Committee I visited the Department of Pharmacology in the University of Oxford.

The UK as an environment for pharmaceutical research

The Department of Health (p193) consider the UK to be a good environment for investment in pharmaceutical research. One important factor is the Pharmaceutical Price Regulation Scheme (PPRS), agreed between the Department and the ABPI, and renegotiated last year for five years. The PPRS actually regulates not prices, but each firm's overall profits on sales to the NHS. The Scheme includes a Research and Development Allowance of up to 22½% of total sales; given that the average research investment of pharmaceutical companies is 15% of sales, the Department regard this as "a generous level of support". The Scheme allows freedom of pricing for the UK launch of genuinely new products; this means that companies can go straight to market after receiving a Product Licence, can set launch prices so as to recover R&D costs fairly quickly, and are not handicapped by an artificially low UK price when negotiating prices overseas.

The Department lists further advantages of the UK: the "unique testbed" for clinical trials offered by the NHS, with the added advantage of the English language; the UK Medicines Control Agency, which issues promptly product licences which are respected around the world; and the European Medicines Evaluation Agency (EMEA), which is to be located in London. The Department concludes by citing its own commitment to research, embodied in the appointment of an NHS Director of R&D, Professor Michael Peckham, and initiatives which include his strategy document entitled *Research for Health.*

The witnesses brought before us by the ABPI painted a less rosy picture than the Department of Health. First, they regard the Research and Development Allowance in the PPRS as "helpful" (Q162 - Dr Peter Ringrose of Pfizer), but not "a major factor in terms of persuading us to come here in the first place and as a factor influencing our continued and future investment". They regard as distinctly unhelpful (QQ166, 229) various other measures now being introduced by the Government to control the NHS drugs bill: cost cuts, price freezes, proposals to extend the Limited List (of drugs prescribable on the NHS for certain conditions) to further treatment groups, and proposals for "generic substitution", forbidding doctors to prescribe a patent-expired medicine when a generic equivalent is available at a lower price. These issues are under consideration by the House of Commons Select Committees on Science and Technology and Health; we have not gone into them in further detail.

Secondly, they report a decline in two areas which they all agree are crucial to pharmaceutical research: the state of relevant basic science, and the supply of trained graduates (QQ189-208, 212). Dr Ringrose of Pfizer pointed to a decline in real terms in the Government's civil R&D budget between 1982 and 1992; a decline in the index of citations of British scientific papers, most marked in biological sciences and clinical medicine, and in the number of Nobel Prizes won by scientists in UK universities and institutes; the under-equipment of university laboratories, and their increasing dependence on donations from industry; and the trend away from science in schools. In a written submission, Pfizer also expressed concern about the effect on the medical infrastructure for research of "the straitened circumstances of the Health Service". Dr Michael Elves of Glaxo described biology and chemistry students graduating with limited practical experience (due to a combination of overcrowding, over-reliance on computer simulation, and avoidance of animal experimentation), and university laboratories which are "still in the 1950s" (though he named Cambridge and Birmingham Universities as exceptions); and he identified particular weaknesses in the newer areas of science, especially molecular biology, in contrast to the older disciplines of chemistry, biochemistry and pharmacology. Dr Robin Fears of SmithKline Beecham commended the Office of Science and Technology's campaign to improve public understanding of science, but deplored the narrow specialisation encouraged by the A-level system; and Professor William Dawson of Eli Lilly told us that the UK has fewer "centres of excellence" than she used to.

Dr Leslie Iversen, Director of Merck, Sharp and Dohme's Neuroscience Research Centre in Harlow, echoed the ABPI evidence. He told us starkly, "If my company was to take the decision today, we probably would not be building a laboratory in Britain" (Q608). He gave his reasons (Q612): gradual erosion of the science base infrastructure, particularly university buildings, while competitor nations (he singled out France and Germany) have invested in improvements; and "increasingly invasive" regulation by the Government. MSD part company from the ABPI in finding the PPRS to be "increasingly limiting our capacity to do research", in particular by setting "arbitrary ceilings" on allowable expenditure on research and medical education. In recent years, new MSD investments have gone to Italy, Japan and Canada.

Our own analysis of the erosion of the science base is set out in our recent report *Priorities for the Science Base* (HL Paper 12). While we agree that there are causes for concern, we do not accept all the causes advanced by the ABPI. We accept that some university laboratories are under-equipped and out of date by industrial or American standards; but the same is true of universities in Japan. As for the effect of the NHS reforms on the infrastructure of medical research, this is an issue which we intend to examine in detail in the autumn.

The ABPI view is in any case rather gloomier than the picture presented by the pharmaceutical companies who have given us written evidence. Merck, Sharp and Dohme expressed concern at "the erosion of the UK science base, both in terms of its size and its quality, in the past decade", but added, "We continue to benefit from exposure to academic science in Britain"; Bayer, Ciba-Geigy and Yamanouchi commended the UK science base and clinical infrastructure, and Hoechst commented on the impending establishment of the EMEA. Even Pfizer were more positive in writing, commenting on "the excellence of the scientists whom we have been able to recruit", "the excellent medical infrastructure" and "the enlightened regulatory approach"; and Dr Ringrose admitted in the course of his oral evidence that things are not as bad as all that:

> "The reasons why we have continued to invest in the United Kingdom, despite my comments about projections for the future, which do genuinely worry me, is that the United Kingdom still does offer an excellent base for not only scientists but also those trained in clinical medicine, and particularly in experimental medicine and clinical pharmacology. This provides an excellent continuum from the basic science into early development and clinical evaluation. Pfizer has recently opened up what we call a "phase one unit" or an exploratory medicine unit, at the Kent and Canterbury Hospital. We have Pfizer staff working within the hospital unit conducting volunteer studies, and that has worked very well for us as a company and also for the hospital trust".

Animal rights terrorism

We asked the witnesses from the ABPI whether the threat of animal rights terrorism might drive pharmaceutical research away from the UK (QQ233-243). They told us that terrorism (which they rightly distinguished from legitimate protest) was a problem unique to the UK, and that it was affecting animal experimentation and the teaching and training of pharmacologists in the universities, and imposing the extra cost of security on university budgets which are already stretched. They attributed it to a combination of the national love of animals, "tolerance of the lunatic fringe", and poor public understanding of science. To address the problem, they called for changes to the criminal law to give greater protection against trespass on company property (see House of Lords *Hansard* 24th May 1994), and a long-term campaign of education, focused on schools, in which the pharmaceutical industry is already engaged.

We put the same question to representatives of the BBSRC, which is involved in animal experimentation for animal biotechnology and veterinary medical research. They acknowledged the cost of security, but suggested that government action might be counterproductive; they do not believe that the threat of terrorism deters companies from placing research contracts in the UK (Q476).

Emerging competition

Besides asserting that the UK environment for pharmaceutical research is in decline, the ABPI witnesses told us that the environment in other countries is improving. From its European research centre in Sandwich, Pfizer is placing an increasing number of clinical studies on the Continent, because of "the quality of clinical studies being carried out in other European countries" (Q212). For Eli Lilly, Professor Dawson said, "...our competitors in Europe are actually catching us up. Many of the European countries now are doing quality science, particularly in chemistry for example and in biological science in some areas, and the opportunities in those other countries are there to be taken" (Q212). He added that postdoctoral collaborations are more expensive in the UK (£40,000 per year per researcher) than anywhere in Europe, for example in France (£30,000), the difference lying in the amount of overheads which the university is required to recover from collaborators (QQ212-5).

Besides a general levelling up of standards, it appears that some countries are positively seeking to attract pharmaceutical research. Spain, as part of a general drive to increase her science and technology base (*Plan de Actuacion Tecnologico-Industrial*), has specific policies for the pharmaceutical sector (*Plan de Fomento de la Investigacion en la Industria Farmaceutica*, or *FARMA*): for a given percentage of profits invested in research in Spain, the regulatory agencies will move new drugs through the system quicker than would otherwise happen; the government is also encouraging academic-industry collaborations, which according to Dr Elves "has done a lot to improve science in Spanish universities" (Q246). We are grateful to the Spanish Embassy for supplying us with the relevant documents. According to Professor Dawson, Canada lost investment in pharmaceutical research through a policy of generic substitution, and is now re-establishing it by linking gross sales to a required investment in research in Canada.

Strategic Research Alliances

A feature of research and development investment in the pharmaceutical sector is the "strategic research alliance" (SRA): a "multi-year, multi-million dollar collaboration between a single company sponsor and an academic research centre". We owe this term and its definition to Dr Andrew Webster, Director of the Science and Technology Studies Unit at Anglia Polytechnic University, who has made a special study of SRAs.

Dr Webster has drawn to our attention five SRAs between international pharmaceutical companies and British universities. Each such arrangement is unique, but they may be crudely reduced to tabular form

Strategic Research Alliances in Pharmaceuticals

Company	University	Start	Investment	Duration	Field
Monsanto/ Searle	Oxford	1983	$20 m	15+ years	Glycobiology
Bristol Myers Squibb	Oxford	1987	$32 m	10 + years	Pharmacology
SmithKline Beecham	Cambridge	1988	$5 m	10 + years	Molecular medicine
SmithKline Beecham	Oxford	1989	$8 m	10 years	Neuropsychology
Eisai	University College London	1991	$75 m	15 years	Neuroscience

To Dr Webster's list may be added two "partnerships" formed by Edinburgh University: with Syntex in 1990 for clinical trials, and with Fujisawa in 1992 for neuroscience. We have received more or less detailed accounts of most of these arrangements from the universities concerned; these are summarised in the Annex.

These arrangements, more than any other form of international investment in UK science, may be perceived as "a selling of the British silver overseas": a foreign company acquiring a privileged position within a British university department, thereby gaining influence over its research programme and access to its expertise and output. In Dr Webster's view (Q 112), this is a false perception. When an SRA goes wrong, the problem tends to be not exploitation, but the management of the relationship; and when researchers are dependent on an SRA, management problems can destabilise their research by threatening their mid- and long-term prospects. Such problems may arise from a change in the company's general research strategy, or a takeover or merger, or a change in the regulatory context (Q146), or the departure of the "personal champions" who created the SRA (Q142). A department which unexpectedly loses a large corporate endowment may find itself at the back of the queue for public funding, behind departments which have not been so favoured. To avoid this risk, the notice period for terminating an SRA is usually long (Q113); and in some cases, to avoid over-dependency, a limit is placed on the ratio of SRA funding to total funding of the department concerned (Q147).

Even if an SRA is not terminated prematurely, Dr Webster observed (Q139) that problems may arise over outcomes. In the first few years, the academic partner is likely to find that "the reins are off", and they enjoy more freedom to "follow their noses" than they would on a research council grant, with all the accountability which necessarily accompanies public funding. After four or five years, however, the industrial partner may begin to press for applicable outcomes; this changes the nature of the relationship, and can create serious problems.

The solution which Dr Webster recommends to this dilemma, is "a two-tiered system": "almost unrestricted core programme funding" for the duration of the SRA, plus "a series of identified research project areas which the company is interested in and into which people can bid for additional funds". Such a system distinguishes clearly between funding which is expected to lead to applicable outcomes and funding which is not; it also simplifies the intellectual property position.

We asked Dr Webster how important a factor was the PPRS in encouraging international pharmaceutical companies into SRAs with British universities (QQ 115-7). He reported one case in which it was acknowledged to be "a vital ingredient", but judged that overall it was not the only factor behind the SRAs; another was the relatively low cost of research in British universities, in both salaries and overhead charges (contrast the evidence of Eli Lilly, Q212, cited above). He mentioned that the PPRS may account for the absence of SRAs between British universities and British pharmaceutical companies (Q113): such companies make their SRAs abroad, having "exhausted the goodwill" of the PPRS in other forms of interaction with the UK science base.

Dr Webster assesses the balance of advantages in a successful SRA as follows (Q119). The company gains access to technological competence either not available elsewhere, or available only at greater cost; access to additional research workers; and "PR and prestige", especially in the eyes of the host country's government. The university gains additional funding, access to equipment (including new compounds - Q122) and postgraduate training opportunities (though not, on the whole, employment - Q158), plus in some cases capital investment which may include a building.

Oxford University, a major beneficiary of pharmaceutical industry support in general and SRAs in particular (see Table), agrees with Dr Webster that everybody wins in a properly managed SRA (pp4-7). For the industrial partner, "Providing the company has chosen the right group, a considerable enhancement of the company's research capability is possible at costs which are relatively modest in industrial terms"; and the relatively unconstrained academic atmosphere may be a better environment for innovation than an industrial laboratory. The university department gains resources "to meet the spiralling costs of research (especially for high-tech equipment)", and "greater awareness...of the problems currently facing industry", not only in research but also at the level of undergraduate teaching.

ANNEX

Some strategic research alliances with UK universities

Bristol Myers-Squibb and Oxford University Department of Pharmacology (p4)

In 1987, what was then the Squibb Institute for Medical Research (Squibb merged with Bristol-Myers in 1989) agreed to provide £20m over seven years to Oxford University Department of Pharmacology. The initial contact which led to the agreement was made at a workshop for pharmaceutical research directors organised by the department in the previous year (Q8). Half the money has been spent on a new and fully-endowed building, opened in 1991; the other half supports research projects. Five research areas in the field of neuroscience have been selected; research arising in these areas (which account for about half the department's research) is offered to BMS for funding; BMS choose projects for funding on the basis of peer review. Funded projects are subject to a 6-month publication delay to allow BMS to file for patents; non-funded projects may be offered to any other source of support except commercial rivals of BMS. Departmental work outside the five selected areas is not affected at all; neither is the MRC Anatomical Neuropharmacology Unit attached to the Department. In 1992 the agreement was extended for a further five years to 1999, with an additional £5.15m for work on degenerative diseases of the nervous system, which is one of the original five areas for funded research. In March 1994, the agreement had so far given rise to 135 publications and seven BMS patents.

G D Searle and Oxford University Department of Biochemistry (p5)

G D Searle, the pharmacology subsidiary of Monsanto, made an alliance with Oxford University Department of Biochemistry in 1984, to support work on oligosaccharides led by Professor R A Dwek. This alliance has led to the building of the Glycobiology Institute, with £3m contributed by Searle; and the establishment of Oxford Glyco Systems Ltd, a company funded by venture capital with Monsanto, the University and Professor Dwek among the shareholders, to exploit commercially technology and intellectual property developed at the Institute.

Eisai and University College London

During the 1980s, Eisai sought to locate research in Europe and Northern America. Talks with UCL began in 1989, and an agreement was signed in 1989, to set up the Eisai London Research Laboratory on the UCL campus. Eisai built a laboratory, at a cost of £12m, which will revert to UCL after 50 years; and committed £50m over 15 years to supporting research. Some of this funds the Laboratory; the rest supports collaborations with UCL. The Research Director of the Laboratory holds a UCL Visiting Professorship, and other staff hold teaching posts. Research is concentrated on neurodegenerative diseases.

UCL now also has a comparable relationship with Sandoz.

Upjohn and UCL

The Upjohn European Discovery Centre ran for five years (1987-92) within the UCL Chemistry Department. This arrangement lay somewhere between a strategic research alliance and a normal research contract. UCL won the EDC, in collaboration with the Centre Paul Broca in Paris, in open competition for research into treatment of diseases of the central nervous system; Upjohn provided funds for five researchers, plus equipment, consumables and overheads.

Fujisawa and Edinburgh University

The Fujisawa Institute of Neurosciences was set up within the Edinburgh University Pharmacology Department in 1992. This followed an introduction by Scottish Enterprise, and a three-year contract research relationship. The University provides the staff and owns any IPR; Fujisawa pays all overheads, and has first option on exploitation.

Syntex and Edinburgh University

Syntex set up a Clinical Research Centre in a disused ward in Edinburgh Western General Hospital in 1990. It is staffed by university researchers, who divide their time between trials for Syntex and their own research and teaching. All salaries and overheads are paid by Syntex, in return for first option on IPR.

APPENDIX 6

List of Abbreviations

Research Councils (since 1 April 1994)

BBSRC	Biotechnology and Biological Sciences Research Council (formerly the Agricultural and Food Research Council, AFRC)
ESRC	Economic and Social Research Council
EPSRC	Engineering and Physical Sciences Research Council (formerly the Science and Engineering Research Council, SERC)
MRC	Medical Research Council
NERC	Natural Environment Research Council
PPARC	Particle Physics and Astronomy Research Council (formerly part of SERC)

Government bodies

DTI	Department of Trade and Industry
HEFC	Higher Education Funding Council (for England, Scottish, or for Wales)
IBB	Invest in Britain Bureau
ODA	Overseas Development Administration
OST	Office of Science and Technology
WDA	Welsh Development Agency

Other Organisations

ABPI	Association of the British Pharmaceutical Industry
COSHEP	Committee of Scottish Higher Education Principals
CVCP	Committee of Vice-Chancellors and Principals
EMEA	European Medicines Evaluation Agency
EU	European Union (formerly the European Communities, EC)

Concepts

BERD	Business Enterprise R&D
GERD	Gross Domestic Expenditure on R&D
IPR	Intellectual property rights
PPRS	Pharmaceutical Price Regulation Scheme
R&D	Research and development
SRA	Strategic research alliance

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